Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JULY, 1914.

VARIABLE STARS.

By JOHN L. HAUGHTON, M.Sc.

(*Continued from page 219.*)

Short-period Variables.

Excluding cluster variables, there are eighty stars whose light is known to vary in a period of less than one month: of these, seventy complete their cycle in less than ten days, and sixteen in a few hours. Nearly all these stars are Sirian or Solar in spectral type, and generally the period is kept with high regularity.

1. Eclipsing Variables.

These stars, which are often known as Algols, from the best known of the group, are the only class of variable stars that are not, to a greater or less extent, " wrapped in mystery." They have been carefully studied by many competent observers, and not only has their *modus operandi* been made tolerably clear, but they have served to throw light on other problems. They may be divided into three classes :—

1. Those in which the eclipsing body is quite dark.
2. Those in which it is very faint.
3. Those in which both bodies are of approximately equal brightness.

This third division, however, is probably equally applicable to many Geminid variables, of which more anon. In these cases the classification overlaps.

Figure 226 shows a few typical light-curves of Algol variables. They are from a paper read by A. W. Roberts before the South African Association for the Advancement of Science in 1903.

In Curve No. 1 he explains the constant light-value at the minimum by assuming that the eclipsing body is not quite dark, but that it completely covers the bright star during the minimum, which lasts for about six hours (see Figure 227, Curve 2). Miss Clerke works out that, if this be so, the bright body must be twenty times denser than its dark satellite, which seems very unlikely. A further objection is that there is no observed loss of light when the supposed faintly luminous satellite is eclipsed. From an examination of the light-curve it would appear—assuming this theory—that the two bodies together give four times as much light as the fainter one ; therefore one gives out three times as much light as the other. For the curve to be that shown in the figure, the fainter star must have twice the diameter of the bright component, *i.e.*, must have four times its apparent area. Then when the bright star is eclipsing the darker one, one-fourth of its light, or one-sixteenth of the total light, will be cut off, and there will be a second dip in the light-curve. This has not been observed (see Figure 227).

Another explanation of the phenomenon is that the eclipsing body is quite dark and smaller than the bright star, and that it makes a more or less central transit over the latter. When ingress was complete the amount of light not eclipsed would remain constant until egress commenced. In this

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case the areas of the dark and bright bodies would have to be as 3 : 4; and, although the absence of a second minimum would be accounted for, a more serious difficulty is introduced. On plotting the light-curve that would be obtained from such a system, Figure 227, Curve 3 was arrived at : from this it will be observed that the fall of light obtained is much too gradual ; hence this explanation fails. The following analogy may, however, throw some light on the subject. It is well known that in the case of a total eclipse of the Moon this body never becomes quite dark : the usual explanation is that the Earth's atmosphere refracts a considerable amount of sunlight, and throws it on to the Moon. Thus an observer placed on our satellite would never see the sunlight totally extinguished. If we imagine the dark body in the system we have just been considering to be surrounded by an atmosphere, it is quite conceivable that, though it occulted the bright body completely, yet its atmosphere would refract a sufficient amount of the light passing through it to render it visible to us. The only difficulty appears to be in the amount of light refracted—one-quarter of the whole. But when we remember the size of the body with which we are dealing, it will appear likely that it would have a very dense and far-extending atmosphere, which would enable it to collect an enormous amount of light.

Returning to Figure 226, Curve No. 2 is that of a totally dark star partly eclipsing a bright one. This is similar to the light-curve of Algol, except that in the latter case the minima are rounded off instead of showing a sharp cusp. This cusp is a feature that requires some explanation, but none appears to be forthcoming.

Curve No. 3 shows a similar pointed depression, but in this case the second minimum tells us at once that we are dealing with two light-giving bodies; and if the darker one just, and only just, completely eclipsed the other one, it would give such a light-curve.

The star which gives its name to this class, Algol, is exceedingly regular in the ebb and flow of its light. Between 1790 and 1880 the period shortened by eight seconds, and then it commenced to lengthen once more. This may be due to the pair revolving round a third dark body, or to a rotation in the axis of the orbits. It is a characteristic of many eclipsing stars, and Professor H. H. Turner has found that there is a relationship between the period of eclipse and the larger period of change of period. In this connection a quotation from his Presidential Address to Section A of the British Association in 1911 is so clear and to the point that it cannot be omitted. He says :—

" The history of variable-star observation affords us many lessons as to the desirability of simply accumulating observations and letting them speak for themselves, instead of being guided by a theory or hypothesis. . . .

"The late N. R. Pogson made a series of excellent observations on the star R Ursae Majoris in the years 1853 to 1860 ; he then seems to have formulated a particularly unfortunate hypothesis, viz., that he knew all about the variation, and he accordingly only made sporadic observations in succeeding years. Now this star, along with many others, varies in a manner which may be illustrated by the occurrence of a sunrise.

"The average interval between two sunrises is exactly twenty-four hours, but this is only the average. In March the Sun is rising two minutes earlier each day, and the interval is therefore two minutes short of twenty-four hours ; as the year advances the daily gain slackens, and at midsummer the interval is exactly twenty-four hours ; then the Sun begins to rise *later* each day, and the interval exceeds twenty-four hours, and so on, so that there is a regular yearly swing backwards and forwards through a mean value, and, as in the case of all such swings, there is a sensible halt at the extreme values. Now, when Pogson made his observations of R Ursae Majoris in 1853–60, it was at the time of halt at an extreme ; the period remained stationary, and the variation repeated itself eleven times in a closely similar fashion, so that Pogson concluded it would continue in the same way. How many instances suffice for an induction ? Many inductions have been made on fewer than eleven. Unfortunately, the period was just beginning to change, and we lost much valuable information ; for no one else repaired Pogson's neglect adequately ; and the whole swing of the period occupies about forty years, so that the opportunity to study the changes he missed has only quite recently returned."

Another irregularity occurs in some Algols, that is, that the variation of the magnitude sometimes exceeds its normal range. For example, S Cancri generally varies between 8·2 and 9·8, but on April 14th, 1882, it was of the 12th magnitude. No explanation has been given of this.

Concerning the spectra of these interesting bodies, it may be noted that they are all Helium or Sirian stars ; most other short-period variables are solar. Another remarkable fact is that they lie along a great circle nearly coincident with the medial plane of the Galaxy.

2. Non-Eclipsing Variables.

(i) Geminids.

Returning to Figure 226, Curves 4 and 5 are probably those of *Geminid variables*. These are a rather unsatisfactory group of stars, as they include true eclipsing bodies, in which the components are of approximately equal brightness, as well as variables which do not eclipse. In other words, all variables whose light-changes can be represented by a symmetrical, even curve, with the minima midway between the maxima, are classed as Geminids, even though in certain cases the spectroscope shows us that the relative motion of the two bodies to the Earth is nil when the minimum

occurs, while in other cases one body is approaching and the other receding at minimum. The first case, of course, represents an eclipse, while the second cannot. In the former case difference in brightness of the two bodies would account for secondary minima, such as are found in the case of β Lyrae, V Puppis, and many other stars (see Figure 228).

Sir Norman Lockyer's meteoric hypothesis will explain both these types of variation. If we imagine a swarm of meteors, with a second similar swarm revolving in an eccentric orbit round the first, the collisions between individual meteorites will be much more frequent when the planet swarm is in periastron than when it is in apastron. The light of the star being derived from these collisions, the brightness will wax and wane regularly; and, as the minimum will be visible from any point in space at the same time, it may well happen that in some cases we see it when the stars have a rapid end-on motion, relative to us, instead of when that motion is nil, as must be the case in true eclipsing variables. Two planetary swarms will, if the "year" of one be twice that of the other, give rise to a curve of the β Lyrae type.

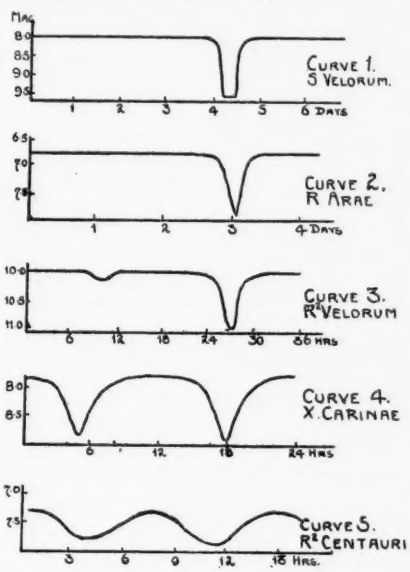

FIGURE 226. Light-curves of Eclipsing Stars.

(ii) δ CEPHIDS.

We now come to the first well-defined class of non-eclipsing short-period variables, those known as δ Cephids.

The distinguishing features of this type of variable are given in an article in a recent number of *Popular Astronomy*, as follows:—

(1) The variation in the light is continuous.
(2) The extent of the variation is about one magnitude.
(3) The period is short.
(4) The light-curves are symmetrical with a tendency to halt in the descent.
(5) The stars are of approximately solar type.
(6) They are small-orbit binaries with only one bright component.
(7) The light and velocity curves correspond in phase, shape, and period.
(8) The stars do not eclipse; the orbits may be at any inclination to the visual plane.
(9) A shifting in the maximum energy point in the spectrum accompanies the light-change, and there are also variations in the positions of the lines not due to orbital motion.

This appears to be a formidable list of qualifications to be possessed by a star before it can be admitted to the rank of a δ Cephid, and yet we find that many such stars exist.

Figure 229 shows the light-curve of the star which gives its name to this subdivision.

Many theories have been brought forward to account for these bodies. As a well-known writer on astronomy says: "The track of recent astronomical progress is strewn with the dilapidated remnants of hypotheses invented to explain the strange phenomena of stellar variability." Only a few of these hypotheses can be considered here.

A. W. Roberts suggested that the variation was due to the faint star receiving more heat from the bright one when in periastron, and thus getting brighter. Clause 6 in the above charter rules this explanation out of court.

L. A. Eddie suggested that the variation was due to tidal disturbance. Professor Campbell, of Lick Observatory, developed this theory, suggesting a tidal disturbance in the atmosphere of the bright star, due to the gravitative effect of the dark one; but no general relationship has been found between times of maximum brilliancy and times of periastron passage; and, further, the theory does not explain the relation between the maximum light and the maximum velocity of approach.

Curtis assumes that the star is moving in a resisting medium. This makes the front of the star brighter.

Lund, of Colorado College, also suggests a resisting medium, assuming a dark primary at rest relative to the medium, and the bright satellite so close that tidal effects make the periods of revolution and rotation nearly equal. This will cause the heated area to be unsymmetrical; hence a rapid rise and slow decline.

Professor Duncan proves that, for this to be true, (1) the diameter must be greater than the Sun, or (2) the density must be several times that of the Sun; (3) the temperature or intrinsic radiating power must be much less than that of the Sun. He states that the first is impossible, and the second and third are not likely, as the spectrum is solar. He assumes the bright star to be surrounded by an absorbing atmosphere. A rare nebulous atmosphere, like the Sun's corona, surrounds the dark star; and, as it rotates, this brushes aside some of the atmosphere of the bright star, so that it is less deep, and therefore more light comes through on the front side. For this reason the maximum light occurs near the time of maximum positive velocity. It has been observed that the logarithm of the light is proportional to the radial velocity, and, for a medium of uniform denseness, the logarithm of the light is proportional to the thickness; hence the radial velocity is proportional to the thickness. The existence of such an absorbing atmosphere

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is well known in the Sun, where Langley has shown that it absorbs from one-half to four-fifths of the light given out. Halving the thickness of such a layer should give a change of 0·8 magnitude. However, the assumption that such an atmosphere is of uniform density seems to be a very big pill to swallow.

Among δ Cephid variables may be mentioned Polaris. This is a recent discovery, and is rather important, as this star had been used as a standard against which to measure the magnitude of others.

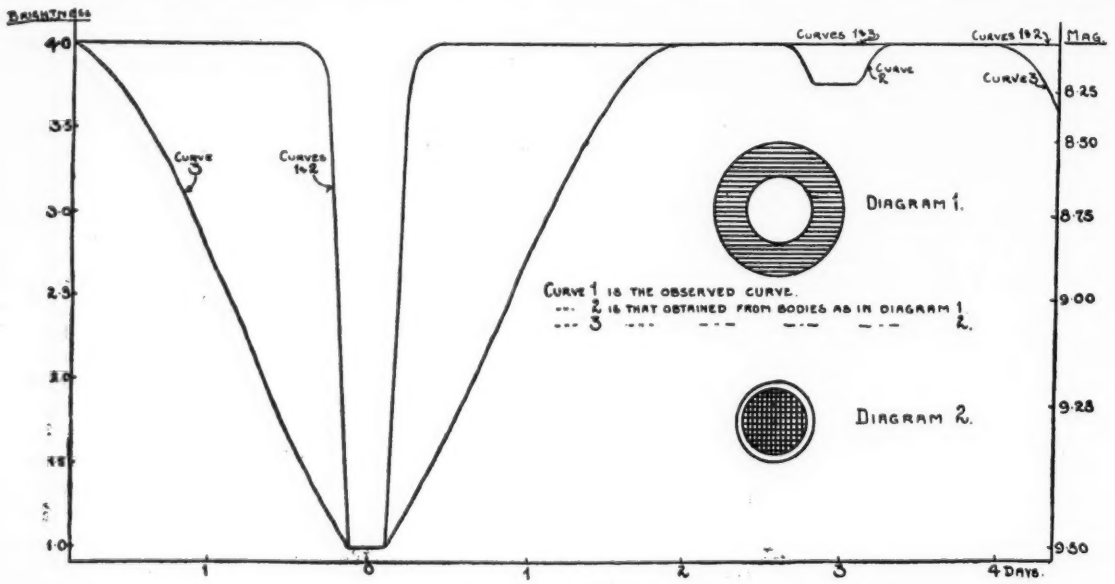


FIGURE 227. S Velorum.

The period is said to be 3·96 days, and the magnitude range $0{\cdot}171 \pm 0{\cdot}013$.

T Monocerotis is also supposed to belong to this class. It has the longest period of any, and the maximum variation of 2·5 magnitudes does not fit in with Clause 2 in the δ Cephid charter. Also, the fact that it is supposed to have a secondary minimum would, were it proved, render void its claim to admission into this select body.

CLUSTER VARIABLES.

The short-period variables of the remaining group are distinguished by the fact that they almost invariably occur in clusters; hence the name. This extraordinary fact, which at first sight would appear to demand a simple explanation, has, so far as the writer is aware, baffled the ingenuity of man in inventing any theory, to say nothing of a satisfactory one, to account for it.

In addition to existing in aggregations, which rule has very few exceptions, cluster variables are characterised by a very short period (generally well under a day, and in one case as short as three hours twelve minutes), which they execute with great regularity and a singularly shaped light-curve (see Figure 230). The rise to maximum is very swift, the fall is much slower, and there is a considerable halt at the minimum. Five hundred of these objects have been observed in the Magellanic Clouds and one hundred and twenty-eight in the cluster known as ω Centauri.

Another variety of variable stars, which is not included as a separate division in Pickering's classification, but which nevertheless merits close observation, is to be found in many double stars. Space forbids us to do more than mention in passing that several of these bodies vary in such a way that the sum of the light emitted by both components is a constant. γ Virginis is a typical example of this class.

COLOUR VARIABILITY.

Not only is the light of many of the stars known to be variable, but there is very good evidence to show that the colour varies also in a few cases.

Sirius is described by Ptolemy as fiery red (*ὑπόπυῤῥοι*); Seneca calls it redder than Mars; Horace uses the term "rubra canicula" as typical of summer heat; Festus describes the custom of sacrificing red dogs at the feast of Floralia to appease the Dog-star; and Cicero, translating Aratus, refers to its "ruddy light." At present no one would dream of calling it anything other than bluish white.

Algol is mentioned by Al Sûfi amongst the exceptionally coloured stars, and in the early part of last century a careful observer noted it as yellow-red on one occasion. It is usually very white.

a Ursae Majoris is said to fluctuate between red and yellow in 54·5 days, and there are many other stars which show decided signs of having undergone colour changes.

In addition to this, all new stars and red variables are also colour variable: the Novae are generally red early in their career, and become leaden white as they fade, while red variables become redder as they get fainter. This latter, however, may be only a physiological effect.

METHODS OF MEASURING THE BRIGHTNESS OF THE STARS.

The earliest observations on stellar variability were much hampered by want of an accurate scale. The stars were divided into magnitudes in a more or less haphazard fashion. To render accurate measurement possible, and at the same time to upset existing nomenclature as little as possible, it was arranged that a fall from one magnitude to the next should be equivalent to a fall in light of 2·512 to 1. (This number is chosen as having 0·4 for its logarithm.) Thus, a third magnitude star gives out 2·512 times as much light as a fourth-magnitude one.

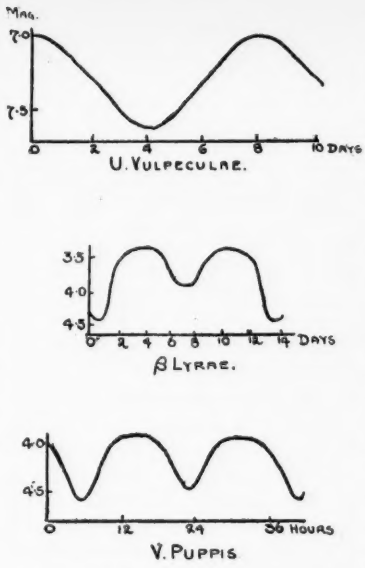


FIGURE 228. Light-curves of Geminid Variables.

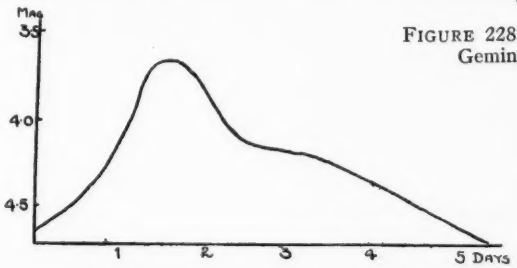


FIGURE 229. Light-curve of δ Cephei.

Having fixed on our scale, the next thing is to use it. The earliest method was to compare the star under observation with a number of stars whose magnitude was already fixed, and find which it equalled, or, failing this, to select one a little brighter and one a little fainter, and, dividing the difference between them into steps, to put the observed variable on that step to which its brightness seemed to entitle it. Thus, suppose two stars, *a* and *b*, and that the observer considers that he can divide the brightness between them into four steps, and, further, that the variable *v* is nearer in brightness to *a* than to *b*, he would enter his observation thus: *a* 1 *v* 3 *b*. If the variable lies midway between the two, the observation is entered *a* 2 *v* 2 *b*, while if it is nearer to *b* than to *a* the entry is *a* 3 *v* 1 *b*. This is known as Argelander's method, and in the hands of experienced observers much good work can be done with it on the brighter variables, while a pair of binoculars will very considerably extend the field of research. The method has the advantage of requiring no instruments, or at most only a field glass, and of not taking much time. On the other hand, it requires fine weather, fair eyesight, and a considerable stock of patience.

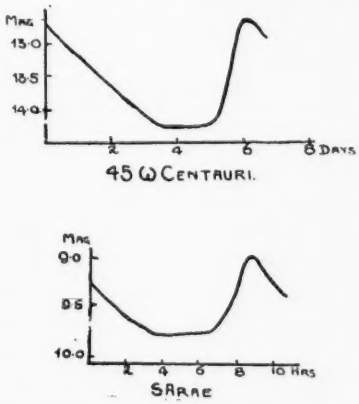


FIGURE 230. Light-curves of Cluster Variables.

For more accurate work, Professor Pritchard, of Oxford, introduced the wedge photometer. This consists of a wedge of tinted glass and a similar wedge of plain glass superposed, as shown in Figure 231. This is slid over the eye-piece of a telescope, until the star is just extinguished, and the thickness of the tinted glass interposed is then measured by measuring the distance through which the wedge has been moved. This process is repeated several times on a fundamental star, and on the other star under observation, and from the mean differences in the two series of observations the difference in magnitude of the stars can be calculated. The instruments used at Oxford consisted of a four-inch and a three-inch telescope, and the magnitude of two thousand seven hundred and eighty-four stars was determined, and published in the *Uranometria Nova Oxoniensis*.

Professor Pickering, of Harvard, employs a fixed telescope, into which he reflects an image of the pole star under observation: by means of a polarising apparatus both the images are made of the same intensity, and from the amount of rotation of the polariscope required to obtain this result the difference in magnitude can be determined. As

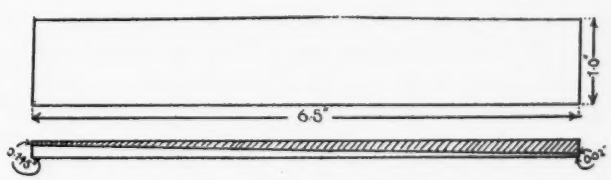


FIGURE 231. Wedge Photometer (half size).

Polaris has been shown to be variable, it will be necessary to apply a correction to the results obtained by this method.

The limit of clearly defined difference that can be observed between two stars by either of these methods is about 0·1 magnitude.

A simple and ingenious method, requiring no expensive adjuncts to the telescope, is mentioned in the *Proceedings of the Liverpool Astronomical Society*. The field of view of the telescope is illuminated, and the eye-piece is racked out until the brightness of the star equals the brightness of the field—that is, until the star disappears. This is repeated several times on a standard star, and on the star whose brightness is required, and the difference in the two means is a function of the difference of magnitude.

We now come to the last, and probably most accurate, method of stellar photometry, *i.e.*, the photographic method. It has the disadvantage that in many cases the results obtained are not strictly comparable with those obtained by visual methods. On the other hand, there are some occasions when it is the only possible method to use, *i.e.*, in the case of very faint variables.

The method almost invariably employed in working out the magnitude of a star from its image on the photographic plate depends upon the fact that the light falling on the plate spreads outwards and produces a small disc. The brighter the star, the larger this disc. The formula generally employed for deducing the magnitude is $M = a - b\sqrt{d}$, where M is the required magnitude, d the diameter of the star image, and a and b are constants, a depending on the atmosphere and b on the plate and unit of measurement. These can be deduced by measuring two stars of known magnitude on the plate. The method is liable to several errors, but most of them are easy to obviate. The principal one is under-exposure, which gives an image which is not black all over, and will show a higher magnitude than it should. Inaccuracy in focusing is likely to be another fruitful source of trouble.

Generally speaking, however, the method is very suitable for photometric work, and, with care, will give results of a high degree of accuracy, as well as permanent records which can be measured at any convenient time.

SOLAR DISTURBANCES DURING MAY, 1914.

By FRANK C. DENNETT.

SOLAR observations were made every day during May. On three days only (10th, 13th, and 14th) did the disc seem free from disturbance. On thirteen (1st to 4th, 6th, 18th, 21st to 25th, 29th, and 30th) dark spots were visible, whilst on the remaining fifteen faculae were seen. There was less activity than in the previous month. The Central Meridian at noon on May 1st was 86° 54″.

As Nos. 9 and 10 remained visible until May 4th and 3rd respectively they reäppear upon our present chart.

No. 11.—A small bright-lipped pore situated in a faculic cloud in high southern latitude only seen on the 6th, but the faculic cloud was visible on the 5th and 7th.

No. 12.—When first observed on the morning of the 21st two spotlets were seen, but by two p.m. tiny pores showed closely behind the western spot; slight changes were noted from day to day until last seen upon the 24th. The length of the group was fifty-six thousand miles.

No. 13 was a group composed of one larger and two smaller pores within the area of No. 9, and only seen on the 22nd.

No. 14 on the 29th appeared as a solitary spotlet, but next day as a group of three; not, however, seen after.

Additionally a small very dark spot is recorded in southern latitudes on May 3rd, but no measures have come to hand, so that it cannot be included on the chart.

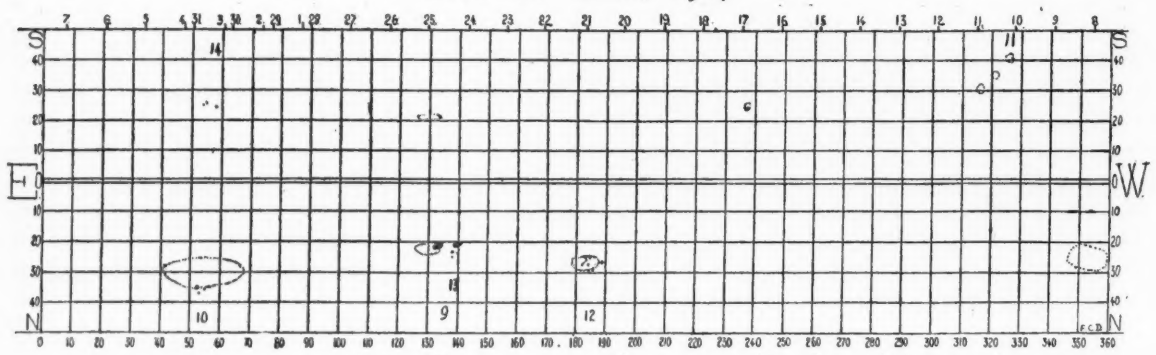
Also on May 18th, in high polar latitudes, a dark spotlet was seen, but not measured.

A pore was also recorded on the 24th, near longitude 202°, in somewhat lower latitude than No. 12. Other pores were noted on the 25th.

Faculae were noted close to the western limb on the 4th, both in north and south latitudes. The fine faculic remains of No. 10 were seen on the 8th and 9th. A bright area around 238°, 26° S. latitude, was seen on the 11th and 12th, and faculae round and about 316°, 30° S. latitude, on the 15th and 16th. The faculic remains of No. 9 were seen on the 19th; also a group round 130°, 21° S. latitude, on the 20th. The faculic remains of No. 12 continued visible on the 26th. Some remnants of the faculae of No. 10 were still visible on the 27th and 28th, as well as that of No. 13. On the 30th and 31st the remains of No. 9 were again visible, as well as a large area around 352°, 25° N. latitude.

Our chart is constructed from the combined observations of Messrs. John McHarg, A. A. Buss, E. E. Peacock, J. C. Simpson, and the writer.

DAY OF MAY, 1914.



STRUCTURAL MODIFICATION AND SPECIALISATION OF FUNCTION.

By HAROLD A. HAIG, M.B., M.R.C.S.

(*Late Lecturer in Histology and Embryology, University College, Cardiff; Research Fellow, University of Aberdeen.*)

The correlation in an organism between histological differentiation and specialisation of function is a principle depending upon factors, many of which are capable of explanation, and others which, as yet, are not fully understood. Thus, the successive developmental phases which are passed through by any vertebrate type from the fertilised egg-cell to the cell-complex which constitutes the animal at birth, show quite clearly that ancestral influences are at work, and that, given adequate facilities for obtaining nutrition, the cells which compose the several germ-layers (epiblast, mesoblast, and hypoblast) have impressed upon them a specific capacity for producing specialised cell-aggregates or tissues; whilst, on the other hand, the actual underlying causes which bring about the differentiation of the cells of various tissues are frequently of so obscure a nature that the biologist is forced to admit that, although he may know something of the forces at work, he has no knowledge of the manner in which these forces are coördinated.

The *animal cell*, of which the unfertilised ovum may be taken as a typical example (see Figure 234), possesses a structure which has been rendered more or less evident by means of the microscope. Examined in the living condition, it is seen to be composed of a small spheroidal mass of semi-fluid viscid material of a somewhat granular appearance, the *cytoplasm*, in which is suspended a *nucleus*, the latter possessing a well-defined rounded refractile spot, the *nucleolus*, in its interior.* With the exception of the youngest ova, this cell is enclosed by a firm membrane—the *zona pellucida*—a secretion either of the ovum itself or of certain follicular cells which surround the ovum in the ovary, and form with the ovum the structure known as a Graafian follicle.

When submitted to certain processes of fixation and staining, both cytoplasm and nucleus give evidence of possessing a definite, finer structure; thus the cytoplasm frequently shows a fibrillar or, at times, a vacuolated appearance,† whilst the nucleus has suspended in its substance a network, upon which granules of a substance known as chromatin are arranged. The granules in the cytoplasm are for the most part of the nature of food-substances (so-called deutoplasm, or yolk).

The ovum, subsequent to fertilisation, apart from certain changes which take place in the nucleus and the acquirement of a centrosome, a minute body taking part in the process of mitotic nuclear division, is structurally but little changed, but there is no doubt as to its intrinsic difference from the unfertilised ovum. It is capable of dividing, and the resulting cells are endowed with the same capacity, which, if kept stimulated by adequate conditions of environment and nutrition, remains unabated until such time as rudiments of all the tissues and organs have been formed.

The ovum is, however, a specialised cell, just as much as a nerve-cell or a muscle-cell is specialised; nevertheless, in microscopical structure, it may not appear highly differentiated in comparison with these others. The fertilised ovum may be looked upon as even more specialised than the unfertilised, in that its capacity for cell-division is greatly enhanced.

With regard to the early changes taking place during the establishment of any of the tissues or organs, in other words, the histogenesis of these, it has been shown that such changes do not occur at one and the same time in all of them. Thus, two of the earliest tissues to become laid down are those going to form the skin and central nervous system on the one hand, and the connective tissues on the other; but, even in these, full development is not completed until a late period of foetal life, establishment of external form being secured some time before histogenetic changes have wrought much differentiation of the component cells. It is, in fact, a well-established axiom that the more complex the ultimate function to be carried out by a tissue or organ, the longer will the histogenetic changes take to complete.

The more immediate object of the present article is to give some idea of the changes in structure which certain tissues or organs may undergo during their progress towards functional perfection, and in this respect a selection may be made of one or two of the special sense-organs, as forming an interesting study in connection with the correlation existing between structural modification and function. Moreover, it will be advisable to confine our selection to a consideration of the more essential

* The terms "nucleus" and "nucleolus" have been chosen as being more suitable than the older terms, "germinal vesicle" and "germinal spot."

† Such appearances are, however, at times of the nature of artefacts.

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parts of these organs, such as the sensory epithelium and its nervous connections, those parts which subserve the roles of support or movement of the whole or part of the organ being only very briefly described when deemed necessary.

To begin with, it should be borne in mind that the general scheme of a sense-organ, with its nervous connections, is as follows :—

1. **A central sensorium in the brain.**
2. **One or more collections of nerve-cells, forming so-called "relays" upon the sensory path: these at times form definite ganglia.**
3. **A peripheral end-organ, composed of either a simple or a compound epithelium, upon some of the cells of which nerve-fibres form the nearest relay-end.**

A simplification of this scheme is encountered in the case of the sense of smell, in which the basal ends of certain cells (olfactory cells) of the peripheral end-organ are themselves prolonged as nerve-fibres to the first relay. Usually, the nerve-fibres from the nearest relay of nerve-cells form an arborisation (synapse) with processes from cells of the sensory epithelium, or they may end actually upon the cell-bodies of these cells. In the above scheme the arrow indicates that the sense-impulse passes from the periphery to the centre in the brain.

If we take, at the outset, the sense of *sight*, we find at one end of the path the visual sensorium in the occipital lobe of the brain, intermediate relays in certain of the basal ganglia, and at the periphery the sensory epithelium, formed by that complex inner coat of the eye, viz., the *retina*. A brief account of the development of the retina will not be out of place, and will, moreover, be of use in following out the differentiation of the cells of the various layers met with. The rudiment of each eye begins to form at an early stage of embryonic life, and is first seen as an outgrowth from the side of the fore-brain. This outgrowth is known as the primary optic vesicle (see Figure 238 A, *op. v.*). It is hollow, and its wall is composed of several layers of undifferentiated nervous elements of two kinds, viz., *neuroblasts* and *spongioblasts*, the former being forerunners of definite nerve-cells, the latter giving rise, during later stages, to certain peculiar supporting elements having a purely mechanical function. Very soon an invagination occurs at the most prominent part of the optic vesicle, so that a cup-shaped depression is formed; and this goes on until the part of the wall pushed in comes to lie close up against the original lateral and hind walls of the vesicle, very much as when a rubber ball is dimpled in, the bottom and sides may be made to meet the inner surface of the remainder of the ball. The eye-rudiment has now reached the stage known as the *secondary optic vesicle* (see Figure 238 B and C, *op.*). Of the double wall now seen, the outermost, *i.e.*, that farthest from the brain, will form the retina proper, that next the brain forming the pigmented epithelium of the retina of later stages (see Figure 236, R and P). The rudiment of the sensory epithelium formed in the above manner is composed of a good many tiers of comparatively undifferentiated cells, which have been derived ultimately from the outer germ-layer, or epiblast. As development proceeds, these cells become arranged into several compact layers, but the cells composing the various layers are for the most part similar in appearance to one another, and remain so for some time. In the human embryo of five and a half months' development the retina is represented by seven well-defined layers; but these are not all cellular in structure, some being composed merely of interwoven processes derived from zones on either side of a given layer; moreover, the number of layers is not increased during later stages, so that further differentiation results in a modification of the component elements of layers already laid down.

It will now be as well to examine the microscopical appearance presented by a vertical section of the fully formed retina of any one of the higher mammals; such a section, if thin and appropriately stained so as to show up the various elements, will reveal the following details (see Figure 232) :—

Passing from without inwards—

(*a*) A layer of cells containing pigment, and only one cell thick. This is the pigmented epithelium of the retina, and, as has been seen, is derived from the thinner outer wall of the secondary optic vesicle.

(*b*) A layer of "rods" and "cones," which are the outer segments of peculiarly modified cells. The rods alternate with the cones, the former possessing the shape of an elongated cylinder, whilst the latter are somewhat shorter, and not unlike the peg of a peg-top. Both are translucent when untreated by fixing reägents, but may show peculiar refraction effects which give them a striated appearance.

(*c*) A delicate membrane, the so-called external limiting membrane.

(*d*) The outer nuclear layer, composed of the nuclei and delicate cytoplasmic portions of the rod and cone cells: these nuclei may also present peculiar transverse striations.

(*e*) A layer, the outer synapse layer,* made up of the interlacing protoplasmic fibrils derived from the inner ends of the rods and cones on the one hand, and outwardly passing processes from cells of the layer next internal (bipolar cells).

* Sometimes known as the outer molecular layer.

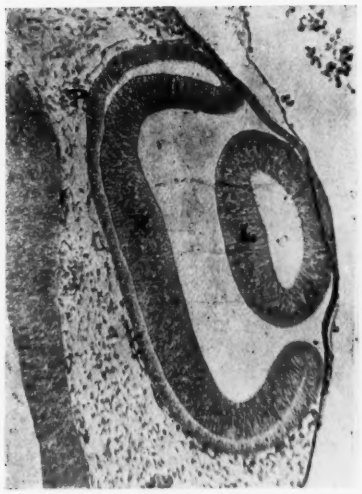

FIGURE 236.

A horizontal section through the developing eye (= secondary optic vesicle) of the 3rd-day Chick.

R. The inner layer which becomes the retina of later stages. P. The layer giving rise to the pigmented epithelium of the retina. L. The rudiment of the crystalline lens: this is derived from the epiblast at the side of the head, and becomes cut off from this later and forms a hollow vesicle.

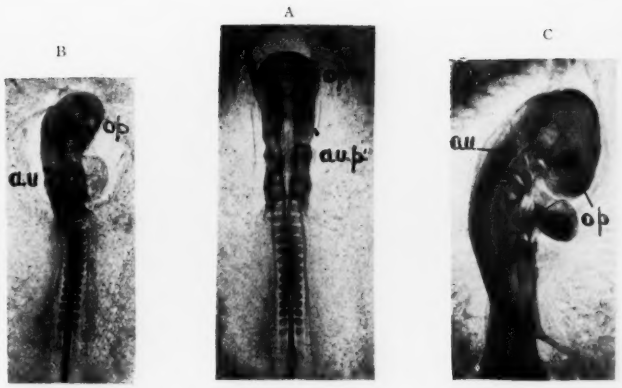

FIGURE 238.

Chick-blastoderms of the 2nd (A) and 3rd (B and C) days of incubation: the developing embryos show incidentally rudiments of the central nervous system, eye and ear, and vertebral column.

A. { op.v. Primary optic vesicle showing as a protrusion from fore-brain.
{ au.p. Auditory pit lying close to the side of hind-brain.

B and C. op. Secondary optic vesicle. au. Auditory pit (in B) and vesicle (in C).

[From photographs.]

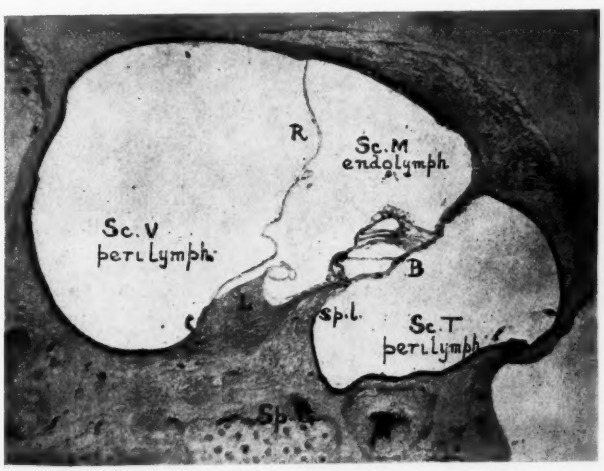

FIGURE 237.

A vertical section through one turn of the cochlea of a Guinea-pig.

Sp.G. Spiral ganglion.
Sp.l. Spiral lamina.
l.s. Spiral ligament.
R. Reissner's membrane.
B. Basilar membrane with organ of Corti upon its upper surface: the rods of Corti are well defined, as also are the other supporting cells.
L. Limbus, from tip of which the shrunken membrana tectoria projects.

The other letters as in Figure 235.

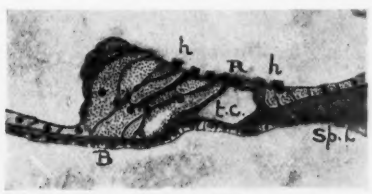

FIGURE 239.

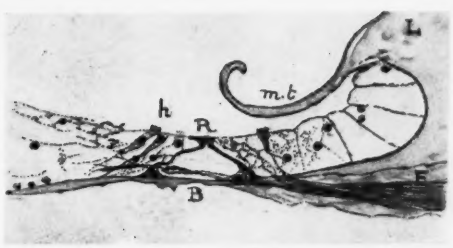

FIGURE 240.

Vertical Sections through the organ of Corti in the Guinea-pig (Figure 239) and Rat (Figure 240).

m.t. Membrana tectoria (in Figure 240).
R. Heads of rods of Corti. t.c. Tunnel of Corti (in Figure 239).
h. Acoustic hairs projecting from free ends of hair-cells.
F. Peripheral fibres from cells of spiral ganglion, ending in hair-cells.

The other letters as in Figure 238 C.

[From high-power photo-micrographs, in which the salient features have been inked over.]

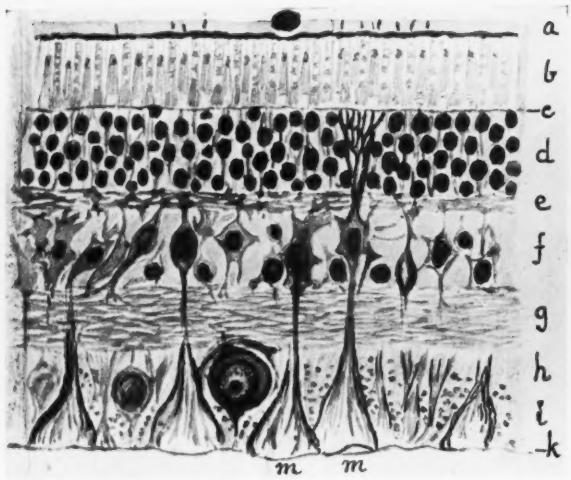

FIGURE 232. A vertical section of the Rabbit's retina.

a. Layer of pigmented epithelium. *b*. Layer of rods and cones. *c*. External limiting membrane. *d*. Outer nuclear layer. *e*. Outer synapse (molecular) layer. *f*. Inner nuclear layer (bipolar cells). *g*. Inner synapse (molecular) layer. *h*. Layer of optic nerve-cells. *i*. Layer of optic nerve-fibres. *k*. Internal limiting membrane. *m*. Expanded bases of fibres of Müller.

[Drawn from a photo-micrograph. The rod and cone layer has been represented diagrammatically.]

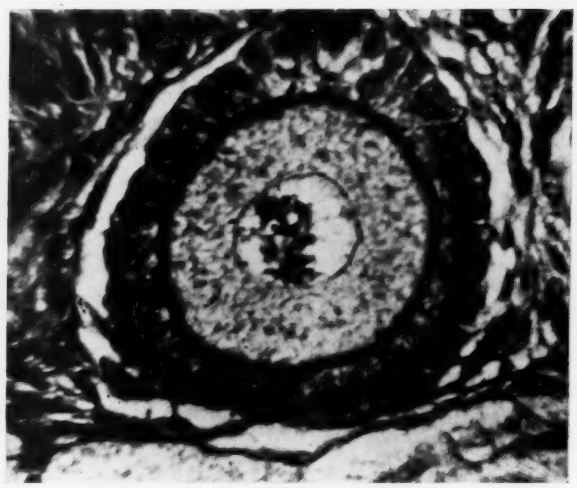

FIGURE 234. A young Graafian follicle from the ovary of the Rabbit.

The dark thick circle is the zona pellucida, and the ovum lies inside this. The rounded body in the middle is the nucleus, which contains a mass of chromatin, and the nucleolus to the left and above close to the nuclear membrane. A single layer of follicle cells is seen just outside the zona.

[From a photo-micrograph, $\frac{1}{6}$-inch objective. No. 3 ocular. Bausch & Lomb.]

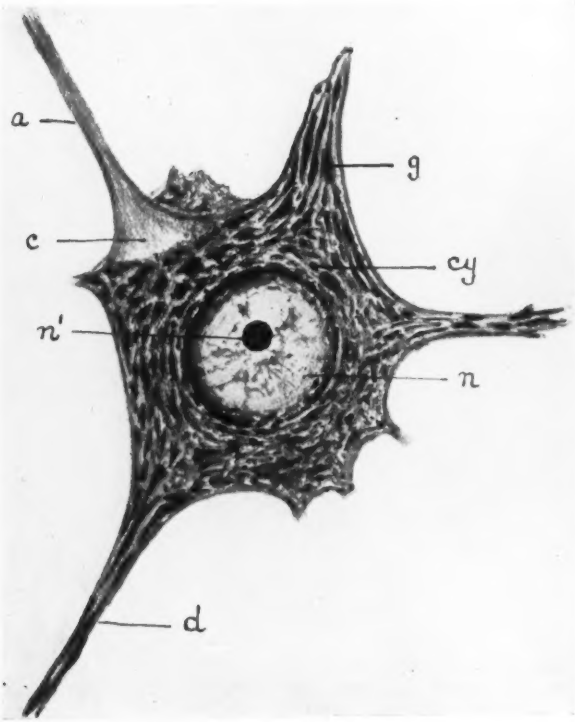

FIGURE 233. A single multipolar nerve-cell from the anterior horn of grey matter of the Sheep's spinal cord, stained with methylene-blue by Nissl's method.

a. Axon or nerve-fibre process. *c*. Junction of axon with cell. *cy*. Cytoplasm of cell. *g*. Nissl's granules. *n*. Nucleus with well-marked central nucleolus (*n'*). *d*. One of the dendrons, or processes of cell, showing also Nissl's granules.

[Drawn under $\frac{1}{12}$-inch oil-immersion objective. No. 3 ocular. Bausch & Lomb.]

FIGURE 235. A median vertical section of the cochlea of a Guinea-pig.

A. Bony wall of cochlea. *C.n*. Cochlear nerve passing up through the modiolus. *Sp.g*. Spiral ganglion cut across several times on either side. *B*. Basilar membrane: the organ of Corti is seen situated upon the upper surface of this. *R*. Reissner's membrane. *Sc.v*. Scala vestibuli. *Sc.m*. Scala media. *Sc.t*. Scala tympani.

[Drawn from a photo-micrograph.]

(*f*) A layer of modified nerve-cells known as bipolar cells: their nuclei form an obvious feature, and of the two processes given off by each cell, one passes into the outer synapse layer, the other into the layer next internal.

(*g*) The inner synapse (or molecular) layer, composed of a dense entanglement of fibres derived on the one hand from the bipolar cells, and on the other from outwardly passing fibres (dendrons) of large nerve-cells in the next layer (optic nerve-cells).

(*h*) A zone in which certain very large nerve-cells, the optic nerve-cells, may be seen. Each of these possesses two main processes, one of which passes into the inner synapse layer; the other, after a short vertical course, turns at right angles, and becomes a single fibre of the optic nerve. These fibres run parallel with one another for some distance, the whole set forming the nerve-fibre layer of the retina; but when they reach a point situated at about the centre of the back of the eye, they bend outwards, and together form the trunk of the optic nerve. Many of the fibres subsequently cross over to the opposite side of the brain, at a part known as the optic chiasma, but some continue on the same side, whilst both sets finally end by forming arborisations in the neighbourhood of nerve-cells of the first relay on the sensory path. The latter cells give rise to fibres which transmit the sense-impulse to cells of the second relay, and so on, until, finally, the visual sensorium in the occipital lobe of the brain is reached, in which certain large cortical cells receive the impulse; and here, by an as yet unexplained process, the latter is interpreted as sight.*

It is not intended here to go into the question of the physiology of the sensation of sight, but it may be mentioned in passing that before the actual stimulus affects the optic nerve-fibres it must first pass via the rods and cones, of which the latter appear to be more readily stimulated than the former, and then through the other layers of the retina from without inwards in order; in fact, the rods and cones may be looked upon as a peculiarly modified end-epithelium, and the bipolar cells and large optic nerve-cells as early relays upon the sensory path. Finally, the light-impulse, travelling as a peculiar molecular change, passes along the fibres of the optic nerve to the brain.

In the retina, as above described, there are certain elongated cells, curiously modified so as to form supporting elements: these, the fibres of Müller (see Figure 232 *m*), pass from the surface of the internal layer, where their expanded, funnel-shaped extremities blend to form an internal limiting membrane, through the other layers, until they end in a sort of basket-work of fibrils upon the external limiting membrane. Their nuclei are situated in the layer of bipolar cells (see Figure 232 *f*).

Looking now upon the retina from the point of view of the question of structural modification in response to functional requirements, it is almost impossible to conceive of a more elaborate example of such modification. Many of the elements in the retinal layers retain the characters of nerve-cells, but, on the other hand, the rod and cone cells and the fibres of Müller have departed very markedly from the original type. The optic nerve-cells are possibly those most nearly related to the typical nerve-cell, as evidenced by their shape and the possession of those peculiar bodies, the Nissl granules, which are characteristic of the cell-protoplasm of all typical neurones (see Figure 233), whether motor or sensory in function. These granules may also be detected in the bipolar cells; they stain intensely with such dyes as methylene blue, and have been shown to have both phosphorus and iron in their composition, their chemical reäctions placing them among the group of nucleo-proteïds. If a nerve-cell becomes fatigued, the Nissl granules disperse, and a diffuse staining of the cytoplasm with methylene blue is noticed (so-called chromatolysis).

The series of changes taking place in the original neuroblasts and spongioblasts of the embryonic retina, and giving rise, ultimately, to the highly-differentiated elements found in the fully-developed structure, can be followed out step by step. Moreover, by means of certain histological methods (the so-called chromate of silver methods of Golgi and Cajal), many of the individual cells can be picked out, rendering it possible to trace the connections existing between the elements of the various layers, and so on, to the remoter relays in the sensory path. The underlying causes, however, of the peculiar structural modifications undergone by the embryonic cells are not at all clear, but probably this is a question which can only be approached by a consideration of evolutional factors; as, for instance, by reference to developmental features of the eye of lower animals. However, the retinae of most vertebrates conform to a distinct type, of which the above description gives a brief histological résumé.

The other special sense to be examined as an example of complexity of modification in response to function is that of *hearing*, the sense-organ concerned being a certain part of the internal ear, viz., the *cochlea*. Although, in some respects, the sensory epithelium is not so complicated as that of the retina, it becomes, nevertheless, considerably modified.

* The names and situations of the various relays on the sensory path have been purposely omitted.

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The early developmental features of the internal ear are somewhat different from those of the eye, in that the rudiments of the sensory epithelium are derived from the epiblast at the sides of the head, and not from the cerebral vesicle at all. The epiblast at the side of the head, close to the hind-brain rudiment, becomes pushed in to form on each side a shallow depression, known as the *auditory pit* (see Figure 238 A and B, *au. p.*), and this pit becomes deeper, being finally shut off from the original epithelium in the form of a sac, the *auditory*, or *otic vesicle* (see Figure 238 C, *au.*).

Each vesicle is close to the lateral aspect of the hind-brain, and constitutes at this stage the simple sac-like rudiment of the internal ear. Further stages show that this sac, which is thus seen to be lined by an epithelium derived from the epiblast, becomes modified so as to form a complex system of cavities, the outer walls of these being membranous in structure, and constituting the membranous labyrinth. In certain places the epithelium becomes columnar in type, and forms definite patches of sensory epithelium, and these occur in the following situations,* viz., the utricle, saccule, the three ampullae of the semicircular canals, and along the whole inner border of the spiral curve of the cochlea. Whilst, however, the modified epithelium of most of the above is concerned with the function of equilibration, that lining certain parts of the cochlea is set off for the sense of hearing and the analysis of musical sounds; it is this latter region which will now be more fully described.

The cochlea of a human embryo of about three months' development already possesses the spiral arrangement characteristic of the fully developed organ, the spiral being one of two and a half turns round a central axis known as the modiolus or columella. During its development the internal membranous and epithelial sac becomes encased in a cartilaginous capsule (otic capsule), which, later on, undergoes a process of ossification, in common with the other cartilaginous rudiments surrounding the remainder of the membranous labyrinth.

A vertical section taken through the cochlea at this stage will show the turns of the coil cut across on either side of the central axis, the latter, which is also cartilaginous at this stage, being traversed from base to apex by the cochlear division of the eighth cranial nerve.

Projecting from the modiolus is a sort of spiral platform, known as the *lamina spiralis*, and attached to the free edge of this is a membrane (covered on both sides by epithelium) which stretches across towards the outer wall of the cochlea, and becomes attached to another spirally wound projection, the spiral ligament. This membrane is the *basilar membrane*, and upon its upper surface are arranged the component cells of the essential sensory epithelium. During early developmental phases the cells of this epithelium are, towards the middle of the basilar membrane, elongated and columnar in shape, with somewhat clear borders, whilst on either side they pass into the type of cell known as cubical.

There is another membrane, viz., *Reissner's membrane*, situated somewhat above the basilar, and the two, stretching across from the modiolus to the outer wall, divide the cavity of the cochlea into three compartments, lined by epithelium: the uppermost is known as the *scala vestibuli*, the middle one the *scala media*, or canal of the cochlea, the lowest being the *scala tympani*. In a vertical section these are, of course, seen as spaces lined by epithelium of the general characters noted above. The columnar epithelium upon the upper surface of the basilar membrane becomes modified during later stages of development to form what is known as the *organ of Corti*. The modified cells are partly sensory and partly supporting in function, and the former become intimately associated with nerve-fibres derived from nerve-cells of the first relay. These cells are collected together into a spirally arranged mass known as the spiral ganglion, which in vertical sections of the cochlea is seen cut across several times on either side of the modiolus (see Figure 235, *sp. g.*). Each cell of the spiral ganglion is bipolar in type, that is to say, two nerve-fibre processes are given off from opposite poles of the cell, one of these fibres passing, as has been mentioned above, to the epithelium of the organ of Corti, the other taking a central course towards the brain, to end round a cell of the next relay, from which the impulse is passed on to the sensorium.† A vertical section through the cochlea at the height of its development will show the above-described cochlear structures after they have been modified to fulfil their functional requirements. A good idea of the actual structure may be obtained by considering the section of one single turn of the cochlea, and in this the following details can be made out (see Figures 235 and 237):—

(*a*) The basilar membrane (B), stretching across from the spiral lamina (*sp. l.*) to the spiral ligament (*l. s.*), the latter being a projection inwards of the lining membrane of the outer wall. Upon the upper aspect of the basilar membrane is situated the organ of Corti, and this is partially roofed over by a peculiar tongue-shaped (in section) flap of connective tissue known as the *membrana tectoria*, which is attached by its base to a projection of connective tissue (the limbus, L), seen just above the spiral lamina.

(*b*) The three scalae (vestibuli [*sc. v.*], media [*sc. m.*], and tympani [*sc. t.*]): of these the

* The terms here used denote anatomical names of certain parts of the labyrinth.

† A certain part of the cortex of the temporo-sphenoidal lobe.

upper and the lower are during life filled with a fluid known as *perilymph*, whilst the scala media contains another fluid, the *endolymph*. The scalae vestibuli and tympani communicate with one another at the apex of the cochlea (helicotrema), but the canal of the cochlea is a closed space, any vibrations reaching the perilymph being transmitted either through the basilar membrane or the membrane of Reissner, or possibly both of these.

The most important part of the above apparatus is the *organ of Corti*, and this is composed of modified columnar epithelial cells, some of which function as receptors of sound-vibrations, others being of a purely supporting character (so-called sustentacular cells). The latter are found alternating more or less with the true sensory cells. There is a large number of both types of cell arranged in regular series upon the upper surface of the basilar membrane from the base to the apex, and it is a noteworthy point that the membrane is broader at the apex than at the base of the cochlea. In thin sections, however, it is obvious that only one row of the cells is seen. Two of the supporting cells in each group form very definite objects, and these, which are propped up against one another at a somewhat obtuse angle, are known as the *rods of Corti* (see Figures 239 and 240, R), outer and inner respectively; the rods, together with a portion of the basilar membrane, enclose a space known as the tunnel of Corti, which contains endolymph. The outer rod is described as having a swollen upper extremity, or "head," from which a process (phalangeal process) projects upon the outer side, and the base, which rests upon the basilar membrane, is somewhat flattened out, and has upon its inner aspect a nucleated cell, which represents the original cell from which the rod is derived. The inner rod is shorter, less obliquely set upon the basilar membrane, with a "head" portion which articulates with the head of the outer rod, and a broad base, having a cell upon its outer aspect similar to that accompanying the outer rod.

The true sensory cells lie, one set to the outer side of the outer rod, the other set to the inner side of the inner rod. The outer set are more columnar, and have amongst them a few supporting cells (Deiter's cells), not unlike the rods of Corti, at their free extremities, their lower ends being nucleated protoplasm.

The sensory cells, or *hair-cells*, more properly called, have at their free ends a number of stiff, bristle-like structures (see Figures 239 and 240 *h*.), or acoustic hairs, which project through a kind of perforated membrane, formed in all probability by the fusion of the upper ends of the supporting cells. Altogether, in each group, there are from five to six hair-cells in the outer set and two or three in the inner set, whilst the latter are individually shorter and more cubical in shape than those of the outer set. The surface view of the basilar membrane, with the organ of Corti resting upon it, has a considerable resemblance to the keyboard of a piano, and this has led to certain theories being advanced as to the manner in which the whole structure responds to sound-vibrations travelling in the endolymph, one being that special hair-cells pick out special vibrations, another that the whole basilar membrane responds, and that the "sorting-out" process takes place in the brain. Neither theory is, however, adequate to explain what really takes place, but from certain symptoms observed in cases where the cochlea is diseased, it appears that the organ of Corti at the base responds to notes of different frequency from those affecting the hair-cells at the apex, where, as has been seen, the basilar membrane is broadest.

SUMMARY AND CONCLUSIONS.

In both the sense-organs above described it will have been noticed how the sensory epithelium is modified during development to possess two distinct types of cell, viz., one the true sensory cell, which receives and transmits the vibration (light, sound, and so on), the other the supporting cell which subserves a purely mechanical function; in fact, much the same state of affairs may be recognised in any end-organ. The supporting cells, during early stages, are able to secrete a very tough resistant substance, or even to become partially converted into this material, which gives very much the same staining reäctions as *keratin*. A similar substance, known as *neurokeratin*, occurs as a sort of sheath in the supporting cells (neuroglia cells) of the central nervous system, and also, to a less extent, in the true nerve-cells and their processes.

As to why the various sensory cells, with their peculiar terminal modifications (hairs, rods, cones, and so on), should be able to receive and transmit certain vibrations, or, in other words, to transform varieties of energy into the molecular change known as an impulse, is as yet not fully solved; but there is no doubt as to the intrinsic difference between a sensory cell and one of the type known as "secretory" or "protective" (skin, and so on). As has been seen from the above considerations, the structure of the sensory cell is determined during comparatively early stages; but, even then, it would appear that the most important modification lies not so much in the obvious structural configuration of the cell as in some peculiar and as yet unknown molecular arrangement of the actual cytoplasm, rendering it particularly susceptible to the influence of specific forms of energy. Finally, it is highly probable that the passage of an impulse through such a sensory cell is accompanied by rapidly alternating katabolic and anabolic reäctions, similar to those which undoubtedly occur in a muscle-fibre during contraction.

XUM

THE FACE OF THE SKY FOR AUGUST.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 32.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°	h. m.	°
Aug. 1	8 43·2	N.18·2	16 36·0	S. 27·3	7 25·5	N.19·3	11 22·7	N. 4·9	11 31·0	N.3·9	21 25·3	S.16·2	5 50·2	N.22·3	20 49·3	S.18·5
,, 6	9 2·5	16·9	21 27·0	S. 16·7	7 42·6	20·0	11 43·2	N. 2·3	11 42·4	2·6	21 22·7	16·4	5 52·5	22·3	20 48·5	18·5
,, 11	9 21·6	15·5	1 9·1	N.11·3	8 10·0	20·0	12 3·3	S. 0·2	11 53·8	N.1·3	21 20·2	16·6	5 54·7	22·3	20 47·7	18·6
,, 16	9 40·4	13·9	5 16·7	N.28·2	8 45·2	18·9	12 23·2	2·7	12 5·3	0·0	21 17·6	16·8	5 56·8	22·3	20 46·9	18·6
,, 21	9 59·1	12·3	9 59·2	N.13·1	9 24·3	16·8	12 42·9	5·3	12 16·9	S 1·3	21 15·0	17·0	5 58·8	22·3	20 46·1	18·7
,, 26	10 17·5	10·6	14 23·2	S. 19·3	10 3·6	13·8	13 2·4	7·8	12 28·6	2·6	21 12·6	17·2	6 0·6	22·3	20 45·4	18·7
,, 31	10 35·7	N. 8·9	19 24·8	S. 25·9	10 41·0	N.10·2	13 21·8	S. 10·2	12 40·4	S. 3·9	21 10·3	S.17·4	6 2·4	N.22·3	20 44·7	S.18·8

TABLE 33.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
Aug. 1	+ 10·8	+5·8	309·6	+ 8·3	−20·2	+0·3	182·9	247·7	4 50 *e*	5 10 *m*
,, 6	12·7	6·2	243·5	−16·8	20·0	0·3	253·1	279·8	5 5 *m*	2 13 *e*
,, 11	14·6	6·5	177·4	−21·3	19·8	0·3	323·3	311·8	10 51 *e*	3 24 *m*
,, 16	16·4	6·7	111·3	− 4·7	19·6	0·3	33·4	343·8	1 15 *m*	10 22 *e*
,, 21	18·0	6·9	45·2	+18·6	19·4	0·3	103·5	15·7	7 1 *e*	11 34 *m*
,, 26	19·5	7·1	339·1	+18·2	19·2	0·2	173·5	47·6	7 16 *m*	2 46 *m*
,, 31	+ 20·9	+7·2	273·1	− 7·3	−19·1	+0·2	243·4	79·4	3 11 *e*	7 44 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}4$, $9^h\ 55^m{\cdot}6$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving southward with increasing speed. Its semi-diameter increases from 15′ 47″ to 15′ 52″. Sunrise changes from $4^h\ 23^m$ to $5^h\ 13^m$; sunset from $7^h\ 49^m$ to $6^h\ 47^m$.

ECLIPSE OF THE SUN, AUGUST 21ST.—This Eclipse is total across Greenland; the central line runs from Alstenö, on the Norwegian coast, to Hernosand, on the Baltic coast of Sweden, enters Russia a few miles N.E. of Riga, passes Minsk, Kiev, and Feodosia (Crimea), then crosses the Black Sea and enters Western Asia, traversing Persia and ending in N.W. India. The totality track in Europe extends for fifty miles on each side of the central line, where the duration of totality is $2^m\ 12^s$. Partial eclipse is visible in N. America (part), Europe (whole), N.E. Africa, western half of Asia.

Table 34 gives particulars for the partial eclipse as seen from some stations in the British Isles. The times are in Greenwich Time, except for Dublin and Armagh, where Dublin Time is used.

TABLE 34.

Place.	Beginning. Time.	Beginning. Angle from N.	Greatest Phase. Time.	Greatest Phase. Magnitude.	End. Time.	End. Angle from N.
	h. m.	°	h. m.		h. m.	°
Armagh	10 24 *m*	325	11 34 *m*	0·638	0 43 *e*	103
Dublin	10 25 *m*	326	11 35 *m*	0·620	0 45 *e*	102
Glasgow	10 50 *m*	322	0 1 *e*	0·695	1 11 *e*	106
Edinburgh	10 51 *m*	321	0 2 *e*	0·707	1 12 *e*	107
Liverpool	10 54 *m*	325	0 5 *e*	0·656	1 15 *e*	104
Durham	10 54 *m*	322	0 5 *e*	0·700	1 15 *e*	107
Oxford	10 58 *m*	326	0 9 *e*	0·642	1 19 *e*	104
Greenwich	10 59 *m*	326	0 11 *e*	0·651	1 21 *e*	105
Cambridge...	10 58 *m*	325	0 10 *e*	0·667	1 21 *e*	106

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It will be seen that the lines of simultaneous beginning are parallel to the line from Liverpool to Durham, or from Oxford to Cambridge. The lines of simultaneous ending happen to be almost parallel to those of simultaneous beginning.

MERCURY is a morning star, in elongation 19° W. on 5th; on 30th it passes superior conjunction and becomes an evening star. Semi-diameter diminishes from 4″ to 2½″. Illumination increases from ¼ to full.

VENUS is an evening star, ⅔ of disc illuminated. Semi-diameter 9″. The fact of its declination being south of the Sun impairs the conditions of observation for northern observers. 10′ south of Mars $6^d\ 2^h\ m$.

THE MOON.—Full $6^d\ 0^h\ 41^m\ m$. Last quarter $14^d\ 0^h\ 56^m\ m$. New $21^d\ 0^h\ 26^m\ c$. First quarter $28^d\ 4^h\ 52^m\ m$. Apogee $12^d\ 10^h\ m$. Perigee $24^d\ 6^h\ m$, semi-diameter 14′ 48″, 16′ 24″ respectively. Maximum librations 1^d 7° N., 5^d 5° W., 15^d 7° S., 18^d 6° E., 28^d 7° N., 31^d 6° W. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 35).

MARS is advancing through Virgo. Semi-diameter 2″. The unilluminated lune is on the East: its width is ⅕″. The planet is near Venus on 6th.

JUPITER is in Capricornus, in opposition on 10th. Polar semi-diameter, 22½″.

Configuration of satellites at $11^h\ e$ for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.	East.	Day.	West.	East.
Aug. 1	4 ○	132	Aug. 17	42 ○	13
,, 2	214 ○	3	,, 18	41 ○	32
,, 3	2 ○	143	,, 19	3 ○	12 4●
,, 4	1 ○	324	,, 20	32 ○	4 1●
,, 5	31 ○	24	,, 21	321 ○	4
,, 6	32 ○	14	,, 22	○	124 3●
,, 7	31 ○	4 2●	,, 23	1 ⊙	34
,, 8	○	1324	,, 24	2 ○	134
,, 9	12 ○	⅘	,, 25	1 ○	234
,, 10	2 ○	143	,, 26	3 ⊙	124
,, 11	41 ○	32	,, 27	321 ○	4
,, 12	43 ⊙	2	,, 28	3421 ○	
,, 13	432 ○	1	,, 29	43 ○	12
,, 14	4312 ○		,, 30	41 ○	23
,, 15	4 ○	312	,, 31	42 ○	13
,, 16	412 ○	3			

The following satellite phenomena are visible at Greenwich, $3^d\ 0^h\ 10^m\ 57^s\ m$, IV. Ec. D.; $4^d\ 2^h\ 5^m\ 15^s\ m$, I. Sh. I.; $2^h\ 15^m\ 33^s\ m$, I. Tr. I.; $4^h\ 22^m\ 35^s\ m$, I. Sh. E.; $11^h\ 5^m\ 11^s\ e$, III. Sh. I.; $11^h\ 24^m\ 45^s\ e$, I. Ec. D.; $11^h\ 41^m\ 36^s\ e$, III. Tr. I.; $5^d\ 1^h\ 52^m\ 26^s\ m$, I. Oc. R.; $2^h\ 44^m\ 34^s\ m$, III. Sh. E.; $3^h\ 20^m\ 51^s\ m$, III. Tr. E.; $8^h\ 33^m\ 48^s\ e$, I. Sh. I.; $8^h\ 41^m\ 27^s\ e$, I. Tr. I.; $10^h\ 51^m\ 11^s\ e$, I. Sh. E.; $10^h\ 58^m\ 48^s\ e$, I. Tr. E.; $6^d\ 3^h\ 52^m\ 33^s\ m$, II. Sh. I.; $4^h\ 7^m\ 9^s\ m$, II. Tr. I.; $8^h\ 18^m\ 23^s\ e$, I. Oc. R.; $7^d\ 10^h\ 7^m\ 1^s\ e$, II. Ec. D.; $8^d\ 1^h\ 8^m\ 19^s\ m$, II. Oc. R.; $9^d\ 8^h\ 6^m\ 14^s\ e$, II. Sh. E.; $8^h\ 9^m\ 43^s\ e$, II. Tr. E.; $11^d\ 3^h\ 59^m\ 6^s\ m$, I. Tr. I.; $3^h\ 59^m\ 34^s\ m$, I. Sh. I.; $12^d\ 1^h\ 17^m\ 41^s\ m$, I. Oc. D.; $2^h\ 57^m\ 8^s\ m$, III. Tr. I.; $3^h\ 5^m\ 20^s\ m$, III. Sh. I.; $3^h\ 36^m\ 13^s\ m$, I. Oc. R; $10^h\ 25^m\ 0^s\ e$, I. Tr. I.; $10^h\ 28^m\ 12^s\ e$, I. Sh. I.; $13^d\ 0^h\ 42^m\ 28^s\ m$, I. Tr. E.; $0^h\ 45^m\ 44^s\ m$, I. Sh. E.; $7^h\ 43^m\ 39^s\ e$, I. Oc. D.; $10^h\ 6^m\ 47^s\ e$, I. Ec. R.; $15^d\ 0^h\ 29^m\ 40^s\ m$, II. Oc. D.; $3^h\ 35^m\ 14^s\ m$, II. Ec. R.; $8^h\ 55^m\ 19^s\ e$, III. Ec. R.; $16^d\ 7^h\ 29^m\ 42^s\ e$, II. Tr. I.; $7^h\ 48^m\ 22^s\ e$, II. Sh. I.; $10^h\ 24^m\ 20^s\ e$, II. Tr. E.; $10^h\ 42^m\ 54^s\ e$, II. Sh. E.; $19^d\ 3^h\ 1^m\ 39^s\ m$, I. Oc. D.; $11^h\ 7^m\ 27^s\ e$, IV. Ec. R.; $20^d\ 0^h\ 8^m\ 46^s\ m$, I. Tr. I.; $0^h\ 22^m\ 46^s\ m$, I. Sh. I.; $2^h\ 26^m\ 18^s\ m$, I. Tr. E.; $2^h\ 40^m\ 22^s\ m$, I. Sh. E.; $9^h\ 27^m\ 41^s\ e$, I. Oc. D.; $21^d\ 0^h\ 1^m\ 34^s\ m$, I. Ec. R.; $8^h\ 52^m\ 19^s\ e$, I. Tr. E.; $9^h\ 9^m\ 1^s\ e$, I. Sh. E.; $22^d\ 2^h\ 43^m\ 48^s\ m$, II. Oc. D.; $8^h\ 2^m\ 35^s\ e$, III. Oc. D.; $23^d\ 0^h\ 55^m\ 57^s\ m$, III. Ec. R.; $9^h\ 45^m\ 3^s\ e$, II. Tr. I.; $10^h\ 25^m\ 19^s\ e$, II. Sh. I.; $24^d\ 0^h\ 39^m\ 22^s\ m$, II. Tr. E.; $1^h\ 19^m\ 28^s\ m$, II. Sh. E.; $25^d\ 7^h\ 29^m\ 23^s\ e$, II. Ec. R.; $27^d\ 1^h\ 53^m\ 2^s\ m$, I. Tr. I.; $2^h\ 17^m\ 28^s\ m$, I. Sh. I.; $11^h\ 12^m\ 9^s\ e$, I. Oc. D.; $28^d\ 0^h\ 2^m\ 16^s\ m$, IV. Tr. I.; $1^h\ 56^m\ 26^s\ m$, I. Ec. R.; $8^h\ 19^m\ 13^s\ e$, I. Tr. I.; $8^h\ 46^m\ 10^s\ e$, I. Sh. I.; $10^h\ 36^m\ 43^s\ e$, I. Tr. E.; $11^h\ 3^m\ 46^s\ e$, I. Sh. E.; $29^d\ 8^h\ 25^m\ 10^s\ e$, I. Ec. R.; $11^h\ 21^m\ 18^s\ e$, III. Oc. D.; $31^d\ 0^h\ 1^m\ 27^s\ m$, II. Tr. I.; $1^h\ 2^m\ 17^s\ m$, II. Sh. I.; $2^h\ 55^m\ 21^s\ m$, II. Tr. E.

Up till the 10th, eclipse disappearances will take place to the left of the disc in an inverting telescope, taking the direction of the belts as horizontal. After the 10th eclipse reäppearances will take place on the right. Near opposition the satellites on the disc are very near their own shadows.

SATURN is reäppearing as a morning star, between Taurus and Gemini. Polar semi-diameter 8″. Major axis of ring 40″, minor 18″. Angle P−6°·0.

Eastern elongations of Tethys (every 4th given) $17^d\ 3^h\cdot3\ m$, $24^d\ 4^h\cdot6\ e$, Sept. $1^d\ 5^h\cdot9\ m$; of Dione (every 3rd given) $17^d\ 9^h\cdot9\ e$, $26^d\ 3^h\cdot1\ m$, Sept. $3^d\ 8^h\cdot3\ m$; of Rhea (alternate ones) $20^d\ 5^h\cdot7\ e$, $29^d\ 6^h\cdot7\ e$.

For Titan and Japetus E., W. stand for East and West elongations, I for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan $17^d\ 5^h\cdot9\ m$ I, $21^d\ 3^h\cdot1\ m$ W., $25^d\ 3^h\cdot5\ m$ S., $29^d\ 6^h\cdot4\ m$ E., Japetus $15^d\ 2^h\cdot9\ e$ E.

URANUS is in its best position for the year, being in opposition on 2nd.

NEPTUNE is a morning star, too near the Sun for observation.

COMETS.—See "Notes on Astronomy."

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
May-30 Aug...	333	+ 28	Swift, streaks.
June-Aug. ...	310	+ 61	Swift, streaks.
June-Sept. ...	335	+ 57	Swift.
June-Aug. ...	303	+ 24	Swift.
July-Aug. ..	308	− 12	Slow, long.
July 25-Sept. 15	48	+ 43	Swift, streaks.
July-Sept. ...	335	+ 73	Swift, short.
July-Aug. ...	280	+ 57	Slow, short.
July-October...	355	+ 72	Swift, short.
Aug. 10-13 ...	45	+ 57	Perseids, swift, streaks.
Aug.-Sept. ...	353	− 11	Rather slow.
Aug. 15 ...	290	+ 53	Swift, bright.
Aug. 15-25 ..	291	+ 60	Slow, bright.
Aug. 25 ..	5	+ 11	Slow, short.
Aug.-Sept. ...	346	0	Slow.
Aug.-Oct. 2...	74	+ 42	Swift, streaks,
Aug.-Sept. ...	63	+ 22	Swift, streaks.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower or a combination of several.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 36).

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TABLE 35. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reäppearance.	
			Time.	Angle from N. to E.	Time.	Angle from N. to E.
1914.			h. m.	°	h. m.	°
Aug. 2 ...	BAC 6160	6·4	10 49 *e*	49	11 51 *e*	293
,, 3 ...	τ Sagittarii	3·5	7 5 *e*	83	8 19 *e*	263
,, 5 ...	η Capricorni	4·8	10 2 *e*	46	11 16 *e*	262
,, 7 ...	Wash. 1513	6·8	—	—	10 25 *e*	226
,, 10 ...	δ Piscium	4·6	—	—	9 16 *e*	215
,, 16 ...	BD + 27°·723	6·5	3 20 *m*	30	4 8 *m*	303
,, 16 ...	136 Tauri	4·6	11 48 *e*	76	0 38 *m* *	272
,, 17 ...	BAC 1918...	6·1	2 52 *m*	124	3 41 *m*	223
,, 19 ...	BD + 24°·1806	7·0	—	—	3 36 *m*	263
,, 28 ...	BAC 5603	6·0	6 29 *e*	78	7 41 *e*	296

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.

* The asterisk indicates the day following that given in the date column.

TABLE 36. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
R Sagittae	20 10	+16 ·5	8·5 to 10·3	70·56	July 9.
U Cygni	20 17	+47 ·6	6·1 to 11·8	464	Aug. 27.
V Cygni	20 38	+47 ·8	6·8 to 13·8	418	Aug. 21.
X Cygni	20 40	+35 ·3	6·2 to 7·4	6·1	
T Aquarii	20 45	−5 ·5	6·8 to 13·4	202·75	Sept. 9.
R Vulpeculae...	21 1	+23 ·5	7·1 to 13·6	136·8	Oct. 15.
T Cephei	21 8	+68 ·1	5·2 to 10·8	387	Nov. 15.
W Cygni	21 33	+45 ·0	5·4 to 7·0	irregular.	
μ Cephei	21 41	+58 ·4	4·0 to 4·8	irregular.	

Minima of Algol $10^d\ 5^h \cdot 3\ m$, $13^d\ 2^h \cdot 1\ m$, $15^d\ 10^h \cdot 9\ e$, $18^d\ 7^h \cdot 8\ e$. Period $2^d\ 20^h\ 48^m \cdot 9$.

Principal Minima of β Lyrae August $7^d\ 1^h\ m$, $19^d\ 11^h\ e$. Period $12^d\ 21^h\ 47^m \cdot 5$.

CORRESPONDENCE.

RUSSIAN PEASANTS' ARITHMETIC.

To the Editors of "KNOWLEDGE."

SIRS,—I read with much interest the letter from your correspondent, the Rev. G. T. Johnston ("KNOWLEDGE," Volume XXXVII, June, 1914, page 203), relating to the method of multiplication adopted by Russian peasants, and append the following explanation:—

Suppose p and q be any two numbers whose product is required. Let p be the number to be successively halved (ignoring fractions), and q the number on the other side to be successively doubled. Of the successive quotients on the left-hand side, let the odd numbers occur in the r_1th, r_2th, r_3th . . . r_sth terms of the vertical column which commences with p, the r_sth term being, of course, equal to unity. The first odd term is the r_1th, its value being $\frac{p}{2^{r_1}}$; and the nearest even number contained therein is $\frac{p}{2^{r_1}} - 1 = \frac{p-2^{r_1}}{2^{r_1}}$, so that the second odd term, or the r_2th term, is equal to $\frac{p-2^{r_1}}{2^{r_1} \times (2^{r_2-r_1}} = \frac{p-2^{r_1}}{2^{r_2}}$. The third odd term, or the r_3th term, will be equal to $\frac{p-2^{r_1}-2^{r_2}}{2^{r_3}}$, and so on.

The last odd term, the r_sth

$$= \frac{p-2^{r_1}-2^{r_2}-2^{r_3}-\ldots-2^{r_{s-1}}}{2^{r_s}} = 1.$$

$$\therefore p = 2^{r_1} + 2^{r_2} + 2^{r_3} + \ldots + 2^{r_s}.$$

$$\therefore p \times q = 2^{r_1} q + 2^{r_2} q + 2^{r_3} q + \ldots + 2^{r_s} q.$$

The numbers in the right-hand, or "q" column, opposite to the r_1th, r_2th, r_3th, . . . r_sth terms (only those corresponding to the odd quotients being retained), are $q \times 2^{r_1}$, $q \times 2^{r_2}$, . . . $q \times 2^{r_s}$, and their sum is:

$$2^{r_1} q + 2^{r_2} q + 2^{r_3} q + \ldots + 2^{r_s} q,$$

which is identical with the value of $p \times q$ obtained from the left-hand column.

CHARLES LOMAX-EARP.

CLAPHAM COMMON, S.W.

ZOÖLOGICAL NOMENCLATURE.

By THE REV. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S.

An appeal to Zoölogists to promote and expedite the publication of Professor Schulze's "Nomenclator Animalium Generum et Subgenerum" by generous financial Support.

1.—THERE is a tradition that in a bygone age and a distant clime the curator of a vast zoölogical garden was prompted and helped by divine curiosity to name all the animals of the globe. The tradition expressly says that they were all brought to one of our forefathers, to see what he would call them, and whatsoever he called every living creature that was the name thereof. At that date, apparently, there were no questions of priority. But, unfortunately, as printing had not been invented, the names, according to our modern rules, were not technically published. They were all *nomina nuda*—as naked as Adam himself. The consequence is, as most naturalists know, that animals are still being continually brought to us to see what we will call them. Only, the result is far from being the same as that of primaeval simplicity. For a just discovered buffalo, or antelope, you may publish the most appropriate designation possible, only to find that it has been preöccupied in the same month, or a hundred years ago, for a flea or a frog. In the Zoölogical Society of London not long ago, perhaps with humorous intention, two consecutive contributions discussed the same group of invertebrates. Both contributors were distinguished for their long study and thorough knowledge of the subject. Yet the group was called *Polyzoa* by one of the specialists and *Bryozoa* by the other. In the latter half of the eighteenth century it was thought allowable, in the division of a genus, to give generic rank to some of its specific names, and to avoid tautology by giving new specific names to the species thus promoted. Some of us think that what those ancients did when there was no rule against it ought not to be interfered with. On the other hand, some of us think that it ought to be, and that these old persons had no right to disobey our new rules.

2.—These are merely samples to indicate the complexities and entanglements with which the theory and practice of name-giving are beset. In the history of our science more or less indignant protests have repeatedly been raised against changes of names, on the ground that the changes were unnecessary, though, really, they were often inevitable, because, with the progress of knowledge, the framework of classification becomes inadequate for the picture. But for the lower units of the system, the genera and species, there is probably a general desire to exclude fluctuation, so far as is possible, by reasonable rules for the future, whether or not any reasonable compromise can be proposed for the past. It is no part of my purpose now to define what is reasonable, or to express any preference among the various self-constituted lawgivers who issue rules on this subject. My object is to explain the interdependent importance of two monumental works which are seeking to clear the ground on this very subject of genera and species. They aim at presenting us with a minute and orderly survey of our whole kingdom, leaving no holes and corners with unwelcome and disconcerting contents to be spasmodically discovered in the future.

3.—The first of these is the "Index Animalium," in course of production and publication by our English friend and colleague, Mr. Sherborn. The second is the "Nomenclator Animalium," edited by the veteran German professor, Geh. Regierungsrat Dr. Franz Eilhard Schulze. Each in its field of operations should be credited with the same single-minded aim, to give us complete and precise knowledge of the facts in question. It is common to both that enormous labour, with consequent expense, is involved in accomplishing the purpose aimed at. Now, from a considerable correspondence, I have become aware that the relation between these two great works has been misapprehended. It is evidently sometimes thought that the "all-British" production ought to be preferred to a "thing made in Germany." It is also supposed that what has been done, and is being done, by other agencies is all-sufficing. Thirdly, it has been suggested, perhaps ironically, that if Germany wants a work of its own, Germany is quite rich enough to pay for it.

4.—If, now, I wish to advocate the claims of Dr. Schulze's "Nomenclator," let it not be thought that I am wanting in zeal for Mr. Sherborn's "Index." In its early days that also was exposed to some amount of prejudice. Many years ago I happened to be on the Committee of Recommendations of the British Association. Section D, after its manner, was asking for many grants, including one for the "Index Animalium." But the distinguished president of the Section that year cared not a jot for names. He refused to open his mouth in favour of the "Index." Accordingly, in the strenuous fight for money, that grant must have inevitably fallen through had I not presumptuously intervened, and, almost against hope, prevailed on the committee to make it. May that be a favourable omen for the success of my present pleading!

5.—Will my readers, then, be pleased to consider the difference in the scope of the two undertakings? Mr. Sherborn desires to supply a list of all the generic and specific names that have been applied to animals between the beginning of the year 1758 and the end of the nineteenth century. This herculean task he began in 1890, and with some unavoidable interruptions he has been pursuing it ever since—for most of the time, I believe, practically singlehanded. A wonderful instalment to the end of the eighteenth century was issued in 1902. But every zoölogist will understand how the task has been growing upon his hands during the last century through the almost appalling activity of naturalists and of what some irreverent persons call species-mongers. Centenarians are common enough in these days, so that no doubt many now living will be able to benefit by the use of his concluding volume.

6.—In the meantime Dr. Schulze has in hand the more manageable endeavour to deal with the names of genera and subgenera, but not those of species, from the same starting-point down to the end of 1910. With this limitation he hopes that his work will be completed within three or four years. It is natural to reflect that for the first forty-three years he has at command Mr. Sherborn's published volume. But in return Mr. Sherborn will, I imagine, derive some assistance from Dr. Schulze's work, since a generic name is a sort of sign-post for the discovery of specific descriptions. The original estimate for the number of references that would be required in the "Nomenclator" was one hundred and fifty thousand. That was subsequently raised to two hundred thousand, and with the progress of the work it is thought that even that number will be exceeded. To make sure that nothing is omitted which should be included in the animal kingdom, either living or lost, there will be some thousands of references to the Protista, in the uncertain borderland between animal and vegetable life. Every reference is to be verified afresh. Nothing is to be taken for granted. But if anyone thinks that the work is being

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carried on in any narrow-minded spirit of national rivalry, that is an entire misconception. So far as their services can be obtained, the most eminent specialists in each division and subdivision of the subject-matter are being employed. They belong, not only to Germany, but to Austria, Hungary, Denmark, Norway, Sweden, Russia, England, Scotland, France, Belgium, Switzerland, Italy, and the United States of America. This, as may be supposed, involves a laborious correspondence, much editorial supervision, and, occasionally, the solving of difficult conundrums as to whether a name is really generic, though entered by its author under some other heading. But the partnership with a dozen different countries does not tell the whole story. The division of labour actually extends to more than a hundred collaborators, and still there is room for others. A modest honorarium is offered of twenty shillings for a hundred references. With a total of two hundred thousand, which is the same as two thousand hundreds, you see that this single item of expenditure absorbs two thousand pounds. Perhaps it may seem an easy thing to earn a sovereign by copying out a hundred references. I cannot speak from experience. But to judge by the sport which I have had from time to time in hunting down a single generic name to its source, any hope of making a living out of such pursuits might be compared with the expectation of a man who rents a salmon river in some favourite locality, intending to pay the rent and make a profit out of the fish which he catches. It is true that in any one of the groups—about five hundred in number—into which, for this purpose, Dr. Schulze divides the animal kingdom, for the specialist a good many of the references will be readily attainable. But anyone who has ever dropped a coin knows how the brute metal chooses the most improbable route to hide in the unlikeliest resting-place. Just in the same way intelligent man will enshrine a new generic name in an obscure serial, a book of travels, a faunistic list, or a difficult language, so that the genius of a detective is sometimes needed for tracking it to its lair. This, indeed, has been urged as an argument against the "Nomenclator"; that, after all, it will not attain the completeness at which it is aiming. Human work is rarely perfect. That is scarcely a good reason for withholding the help which is needed for at least trying to reach perfection.

7.—We are bound to remember that, whatever the place of issue, the work, when completed, will be at the disposal of all the world, and that, though all zoölogists may for one reason or another need its assistance, very few of them will need to purchase it. Hence, to those who have borne the toil and anxiety of the publication, there is no prospect of any financial reward. If Germany is a wealthy empire, so, also, is Great Britain. Each, also, has some wealthy naturalists. Yet it would scarcely be an exaggeration to say that they are wealthy, not because they are naturalists, but in spite of it.

8.—Far be it from me, however, to repine at the conditions of zoölogical study. It may well be content with its own fascinations, and, in connection with my immediate object, I cannot forbear to mention the pleasure of genial correspondence, sometimes ripening into personal friendship, with those of kindred pursuits in many nations. Every tiny thread of concord in this jealous world ought to be welcomed for the sake of its example.

9.—To conclude, then, consider the advantage of having all these laboriously verified references gathered, at no distant date, into a single storehouse; consider how largely our British societies, by their collective industry in systematic zoölogy, will have augmented the cost of preparing and printing this great record; consider the very large number of members interested in the subject, who compose those Societies, established, not only in London, but throughout the Empire; and on these reflections should not the hope be founded that we may eventually claim to have taken a chivalrous interest in the progress, and borne a substantial share in the expenses, of the "Nomenclator Generum et Subgenerum"?

The British Association has contributed, in two grants, £150. Individual donations, in response to a circular issued by the Council of the Linnean Society, are as follows:—

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Further donations to the "Nomenclator Fund" will be gratefully accepted by the Editors of "KNOWLEDGE," 42, Bloomsbury Square, London, W.C., or by the Rev. T. R. R. Stebbing, Ephraim Lodge, The Common, Tunbridge Wells, and lists of subscribers will from time to time be published in this magazine.

PORTRAITS OF GILBERT WHITE.

IN the April number of *The Selborne Magazine* an account was given of a copy of the first edition of Pope's "Iliad," in six volumes, which was given by the poet to Gilbert White of Selborne in 1743, on the occasion of his takening the degree of B.A. It was picked up at a sale at Alton by Mr. T. C. Bartlett, and is of particular interest because on the fly-leaves of two of the volumes there are pen and ink portraits. The first is labelled "Portrait of Gilbert White penned by T. C." (see Figure 241), and the other (see Figure 242), though it has above it the initials G.W., is not described. Mr. Rashleigh Holt-White in an article in *The Field* for June 6th accepts both portraits as being those of Gilbert White and expresses the belief that they were drawn by Thomas Chapman, of Trinity College, Oxford, afterwards Gilbert White's colleague as Senior Proctor. The volumes have recently been purchased by the British Museum, and we are able to reproduce photographs of the portraits which the authorities kindly allowed the Secretary of the Selborne Society to have taken.

FIGURE 241.
Sketch from Volume III.

FIGURE 242.
Sketch from Volume V.

PEN AND INK PORTRAITS OF GILBERT WHITE FROM THE FLY-LEAVES OF HIS COPY OF POPE'S "ILIAD."

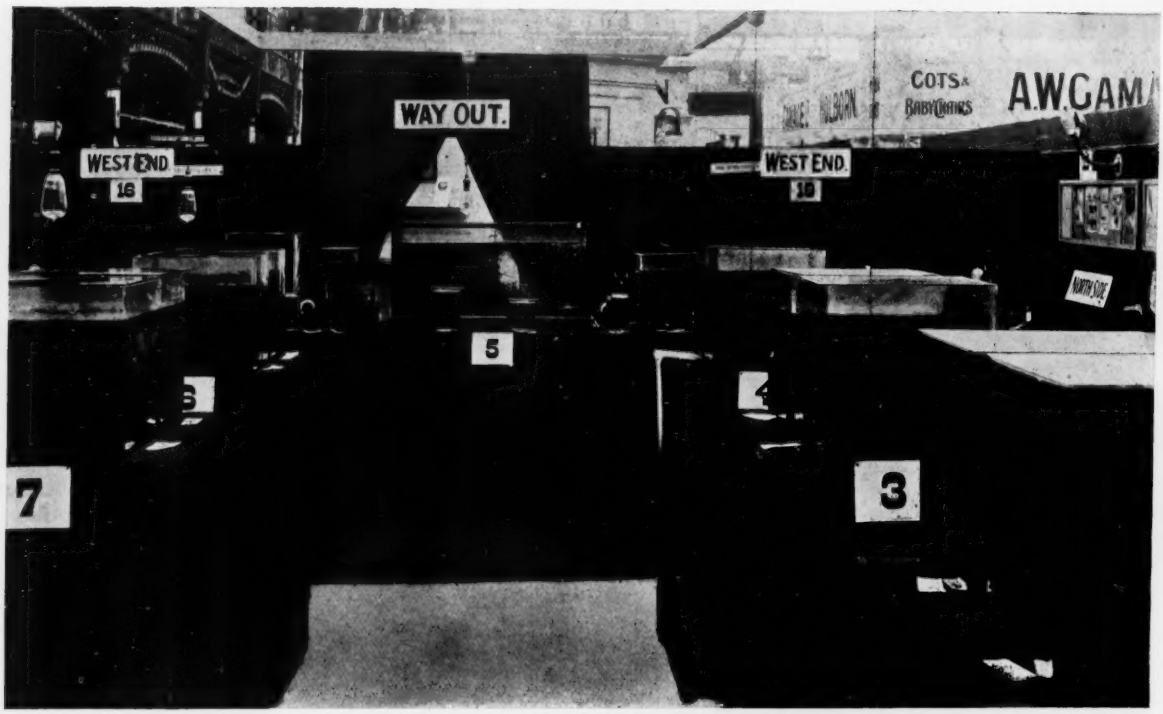

FIGURE 243. Freshwater Aquaria and Vivaria.

FIGURE 244. Marine Aquaria with the Jars used for aërating them and Mounted Specimens.

THE CHILDREN'S MUSEUM AT THE CHILDREN'S WELFARE EXHIBITION.

MUSEUMS AND EDUCATION.

By WILFRED MARK WEBB, F.L.S.

(*Continued from page 156.*)

THE series of articles dealing with Children's Museums is here brought to a close with a paragraph on Botany, and some details with regard to the frames for mounted specimens and aërators for marine aquaria.

As was indicated at the beginning, an actual illustration was prepared, and was shown under the title of the Children's Museum at the Children's Welfare Exhibition, held at Olympia in April. Two photographs, showing details of the exhibit, are reproduced in Figures 243 and 244.

(2) BOTANY.

As the tendency is, or has been, to emphasise the outside of flowering plants, a set of specimens (most of which in the ordinary course of events would find their way to a rubbish heap), showing that a plant has a skeleton, is of importance. Another point of general, as well as of horticultural, interest is the way in which a tree heals its wounds, and the curious way in which the honeysuckle becomes imbedded in the stem of its host can be understood more easily when the way in which wounds heal is known. In this connection also the characteristics of special orders and groups can be demonstrated, and we may have seedlings and flowers dried in sand, collections of fungi, mosses, and what not, on the lines that have already been laid down.

Going outside the scope of the present paper, various minerals and geological formations can be elucidated. We have already pointed to an ethnological collection, while another —something on the lines of the historical section of Sir Jonathan Hutchinson's Educational Museum at Haslemere — could also be elaborated; though here portraits, drawings, and prints might have to supplement natural objects to a considerable degree.

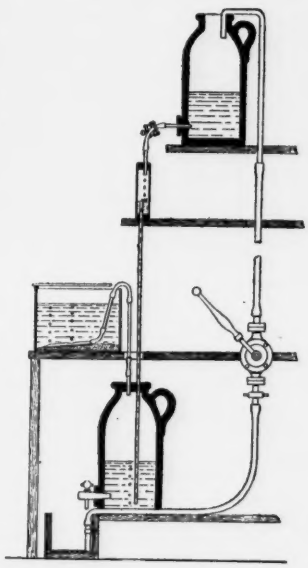

FIGURE 245. A simple aërator for marine aquaria.

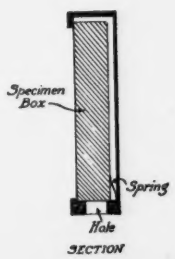

FIGURE 246.

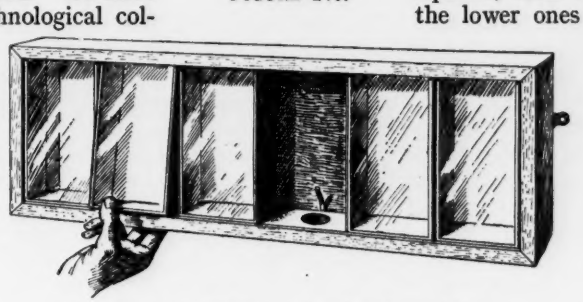

FIGURE 247. Wall-case for glass-topped boxes.

CONSTRUCTION OF THE FRAMES.

The frames in which the glass-topped boxes are contained are so made that any single box can be removed in an instant for examination, or easily replaced by another. Figures 246 and 247 will speak for themselves. The frames have been gradually brought to their present state of perfection, and the design has been registered.

It is obvious that by the use of these frames, which are uniform, a museum can gradually be built up.

AËRATORS FOR MARINE AQUARIA.

Figure 245 shows a simple method of aërating marine aquaria by means of two six-gallon stoneware jars, one above the aquarium and one below. Fresh water is allowed to drip into the glass lamp chimney, the flow being regulated by a pinch cock. As the water goes down the tube below, which is not quite underneath the upper one, it carries air with it into the lower jar, and after a short time the air is forced out, and goes into the aquarium, passing first through a piece of cane, which breaks it up into small bubbles. When the lower jar is full, and the air-tube is disconnected where it passes over the edge of the aquarium, the tap is turned on; water flows into the trough, from which it is easily pumped up into the upper jar again by means of an inexpensive semi-rotary wing pump.

It is convenient to set up several aquaria, each with its pair of jars, and the lower ones can be discharged into the same trough. A fixed pipe runs from this to the pump, but the one leaving the pump can be dropped into the neck of any of the upper jars. Just over one minute is the time spent in the pumping up the contents of a jar.

CONTINUITY AND *X*-RADIATION (WITH SOME NEW EFFECTS).

By W. F. D. CHAMBERS, B.A. (CANTAB.)

THE interest of the *x*-rays for those who have not especially studied them must be considered to fall under two heads: first, the light which they throw, or may hereafter throw, upon the structure of matter and the theoretical bases of dynamics and mechanics; and, secondly, the practical possibility of their application (by way of concentration or otherwise) to the problems of diseased tissues. I shall briefly deal with both these questions, and point out what we believe to be a possible line of advance in radio-therapy.

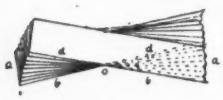

FIGURE 248. Fan-formed model made in sheet materials.
a to *bd*: Each edge shows fine lines.
bd to *o*: These lines disappear and a black band appears from *b* to *o*, and corresponding white band from *d* to *o*.
Point of maximum intensity at *o*.

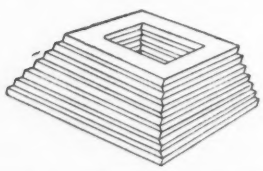

FIGURE 249. Truncated step pyramid hollowed pyramidically, made in firm sheet cardboard (diagrammatic).

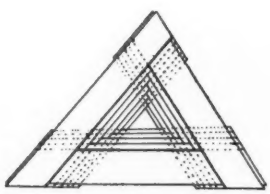

FIGURE 250. Triangular model of paper strips superposed stepwise, the strips produced.

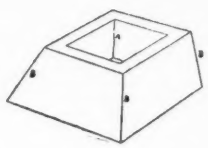

FIGURE 251. Diagram of hollow pyramidal model.

FIGURE 252. Hollow conical model in ebonite.

As being probably the swiftest known form of radiation, the *x*-rays (and γ-rays of radium) enter into competition with light itself, as representing velocities utterly beyond human conceptional powers. And it is still undecided whether that which moves is to be more fittingly described as a series of discontinuous pulses through a stationary medium, or as a material doublet, or β-ray, consisting of positive and negative elements of electricity. Whatever they may prove to be, however, the recent course of research has greatly strengthened the case for their affinity to light, so that if they should turn out to be material, or at least corpuscular, light itself is probably of the same character. But the reader may ask how the solution of this problem would advance human interests in any way; for what, after all, *is* matter?

Some philosophers would invite us to reply to this question in terms such as these. Matter is an affection of special sense-organs, which are stimulated simultaneously or in succession. But what do we mean by "sense-organs," and what by being excited *simultaneously*? The very use of these vague phrases betrays our ignorance of the elements of the mystery, for they imply *almost** necessarily a something independent of the organs competent to do the excitation work.

Again, there are probably few who do not admit that when one of our senses supports another in the observation of some phenomena, the case for its veritable existence is stronger than when one sense pronounces alone. But this takes us a very little way. For the senses, as a rule, register different kinds of impressions; only in a few cases (as where the tactile sense supports the stereoscopy of the eye in ascertaining the rotundity of a three-dimensioned object) do they bear consentaneous witness to the world around. We do not both hear and see the phenomena of a thunderstorm. We *hear* the thunder and *see* the lightning, so that the testimony of a connexion is never free from some discrepancies.

It is upon considerations such as these that the latest speculative theory in physics, Einstein's

* Solipsists would probably suggest that a species of self-induction (as when a man *damps down* his own anger) may be responsible for all phenomena, including matter and its cause.

theory of the Relativity of Time, is founded, and it tries to answer the question, "What constitutes the simultaneous witnessing of phenomena?" The theory begins by throwing all our cherished common-sense and obvious judgments to the winds. According to its exponents* we *must* doubt that if we take a measured distance from A to P, and another distance from P to Q (both these distances being measured along one and the same straight line), the result is a mathematical sum at all. The answer is not $ap+pq$, but perhaps is fundamentally, and for ever, what is called an inequation, *i.e.*, the Universe is everywhere unintelligible and incommensurable. But, on the other hand, we are not obliged to follow these doubts, founded though they be upon refined experiments upon aether-matter reäction and energy distribution in atomic fields. We may say that space-perceptions, though not additive, are yet exponential, or multiplicative, *i.e.*, a *specific* logical geometry attaches to them, although the results in all sciences contain something more than existed before; more than the components contain. In other words, there is a kind of "special creation," a springing into existence *de novo*, in each of our sense-organs, or in the particles they perceive.

"Time will doubt of Rome," wrote Byron, but even he could scarcely stretch his imagination to the point of doubting Time itself; and yet this is what the Relativity principle invites us to do. Events are not "simultaneous" unless a stop-watch near the moving object (suppose we are observing the occultation of a star) confirms a stop-watch near the observer. Nor is this sufficient. The observer must not be himself moving relatively to the object observed; he must, in the one case where a reliable criterion exists, be situated at a fixed centre of gravity between two stars revolving round it, and transmitting to him *instantaneously* the impressions of their motion. It is a further deduction that when two trains are "moving" side by side at the same speed, the apparent rest produced on the senses of an observer in one of them might be real rest, but that such *coincidences* with our present senses cannot occur. There may be a static or motionless world underlying the phenomenal.

A less probable paradox doubts also the identity of energy observed in different systems. If several observers visualise (the author quotes the *ideas* from Mr. Campbell, and accepts no responsibility for the illustrations) a rifle-bullet in flight, each observes only the energy *in his own system.* The system Earth-Moon being different from the system Earth-Mars, an observer on the Moon perceives a motion of the Earth actuated by a different energy, as well as over a different arc, from that seen by the Martian; and yet, though there were infinite numbers of observers, the energy observed is finite.

The principle of introducing the "personal equation" into the Newtonian dynamics of relative motion, thus changing the "equal and similar arcs," and problems of two bodies into systems of three, was discussed by the present writer in 1900,† before Einstein galvanised the paralytics of a belated orthodoxy; but it is a wholly different thing to make this a ground for discarding a mechanics and a symbolism (the differential calculus) which only require extension. Thought, at the point of vantage, cuts up motion into stationary "quanta," and continuity is to be sought beyond and above the planes of material energy. No competent philosopher can suppose for a moment that it does not exist there, since concatenated thought surely exists here.

To sum up as shortly as possible. The Relativity philosophy, if expounded by those who seek nothing beyond undiscriminating novelties, is that of incoördination, dislocation of the senses, pluralism, lawlessness, the extinguishment of the idiosyncratic and the unique.‡ Developed with due regard to its inevitable pivot of certainties beyond phenomenal fluxion, it will become the most powerful solvent of prejudice, and monopoly, to "close the interests of all."

But how does this bear upon the problems of the x-radiation, and why is it that the advocates (like Sir Oliver Lodge) of the old Aether theory are so anxious to retain their grasp upon *material* continuity, which they see slipping through their fingers?

Continuity is the last support of method in science, the last hope of constructive mechanics. With the elements of light and electricity material, and matter *merely* a function of speed, and no independent variable, or independent constant on which they may depend with any sense of certitude, phenomena become a fantastic and inconsequent dance upon a background of nothingness.

It is therefore of profound consequence to human destiny what light, what x- and γ-rays may turn out to be, and to do. They lie upon the border-line between Matter and Aether; to paraphrase Sir Oliver Lodge, the electron has now become the engine of discontinuity, red ruin, and the breaking up of laws. In our view, continuity surely exists, but it is not to be sought on physical or substantial planes; it is the Infinite Binding Power of mental states; it directs the aspirations of the Finite across the invisible bridge of the Unconscious. It has now been shown by Mr. Rankin and the writer that x-rays with a theoretical "wave-length," or orbital diameter, between 10^{-8}

* "Modern Electrical Theory," Norman Campbell, 1913.

† The spiral law of organism.

‡ It appears at first sight to lay stress on the individual, but in attacking Order it withdraws his rights.

XUM

and 10^{-9} centimetres take notice of so-called non-crystalline bodies. But the limits of systematic molecular arrangements have not yet been found. Colloids may be crystalline, crystals may exist from absolute zero to temperatures of the hottest stars. Indeed, it appears that something answering to the release of the element helium from the system of the radium-atom takes place in all gases, this enfranchisement being effected as if by spontaneous volition at critical points only. For such action could be foreshadowed in a preformed mechanism, as a clock is made to strike at a given time.

In former communications (*Nature*, June 19th, August 14th; *Röntgen Journal*, "KNOWLEDGE," October, 1913, and so on) we showed that effects simulating diffraction and polarisation of light can be obtained with *x*-rays falling on metallic bodies. Black and white bands appearing, as in illustration (see Figure 253), on a short exposure, without the rest of the features of the solid models (placed normal to the rays), indicate the special quantity, intensity, or efficiency of the rays along these lines, or at least they evidence the fact that these uniform bands cannot be due to secondary or excited radiations. Secondary radiations are supposed to be equally produced in all directions. The connexion of the white and black bands, and their mechanical separation by the use of models laminated spirally and fanwise, has, we believe, never been shown before, and it is seen with a great variety of substances—ebonite, celluloid, paper, paraffin-wax, chalk, mica, and various metals. In fact, given the conditions, we believe the effects are perfectly general. The use of the fans (see Figures 248 and 258) is to demonstrate that, with *individual* thin strips, the bands are exceedingly narrow, visible only under the microscope; but as the strips approach the point of divergence, at a certain distance a centimetre or so from the origin, the black band begins to show visibly broader *at the foot of the steps*, whilst a white band of corresponding breadth makes its appearance at the top. This suggests both a shift of the beam as a whole and a summation. There appears to be an optimum breadth for the steps, somewhere near one hundred to the inch, or about ·3 millimetre per strip.

We have used bulbs of all hardnesses, but a soft-radiation of 1 to 1·5 milliamperes is found to give the best results. The standard distances have generally been 50 centimetres between the obstacle and the anticathode, and 10 centimetres between the former and the plate. Reversing the position of the step-models (see Figure 256) towards the rays, and changing the angle of incidence, does not destroy the effect; indeed, with angles of forty-five degrees well-marked broad black and white rings are obtained. When the supposed diffraction of *x*-rays was observed by Sagnac and others in early days (1897), and recently by Laue, Friedrich, Barkla, and Bragg, screens with apertures, which themselves produce in a small amount these edge-effects, were employed. Our experiments have been free from this objection, since no screen whatever has interrupted the rays on their path from the glowing spot supposed to be their origin on the anticathode to the model. With apertures a fraction of a millimetre wide, we believe that the edge-effects would amount to quite fifty per cent. of the rays passing through it, and we even surmise that the two "peaks" of intenser radiation (tested by electroscope) may be related to this effect. These peaks have been observed by Bragg and Mosely in a great number of elements, and attributed to the crystals reflecting the rays. In our view, they may be composite—heterogeneous—a part being produced by the apertures.

Friedrich, who obtained haloes nearly at the same time as ourselves (vide *Nature*, June 13th, 1913) on passing the rays through paraffin-wax, after traversing two metal screens, attributes them to the action of atoms inside the crystals, and speaks of a possible polarisation. He describes the phenomena as of "great interest and importance." We have found that once the rays have been changed in this way, the black bands, at all events, refuse to be changed again.

It was an obvious course to construct solid models, built up with strips, and presenting narrow steps at the edges to the radiation, and to compare these with similar models having plane surfaces. Then the surprising fact appears that the bands are still there, as though even a plane surface acted like steps, and in addition to them the sloping interior and exterior dihedral angles are marked by broad bands—white if a pyramid surface is presented to the rays, black if a similar model is made hollow—and it appears to be a condition of the effect that the exterior and interior surfaces shall not be parallel. This may be expressed thus. When *x*-rays fall upon the sloping surfaces of solid bodies they produce a black or white band at the edges, according as the dihedral angle (*i.e.*, the angle between two surfaces) is greater or less than one hundred and eighty degrees. This would be a natural consequence if we conceive the rays being generated *at great speed* on the surface of a rapidly expanding cone and following a spiral course, so as to strike nearly all points of a hemisphere. The amount of discontinuity evidenced by intensity difference in azimuth (Friedrich, *Phys. Zeit.*, April 1913) and in direction sixty degrees from the normal (Kaye) is surprisingly little. It is also consistent with the hypothesis that the rays may be thus divided into two main types of radiation, evidenced by the black and white bands. It is also of interest to remember that, before the undulatory theory was even born, Newton supposed that his particles were effected near the edge of matter by some force causing them to be deflected into convolutions, and sinuous curves, a repulsive force which may outpace gravitation (as in the

FIGURE 253.
From model in paraffin wax, having three grooves. Angle of incidence to grooves 70°, exposure 30″, distance 25 cm. 1 milliampere.

FIGURE 254.

FIGURE 255.
From model of paper strips in form of spiral staircase (half-spire) showing concentration in the direction of axis and borders on the top and bottom steps as white parallel bands.

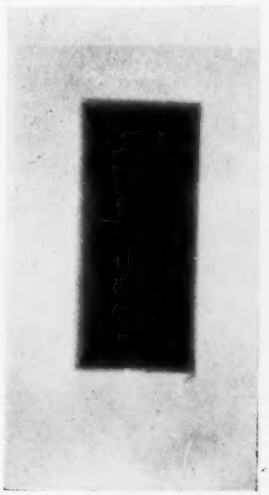

FIGURE 256.
From pyramidal (truncated) model of laminae of mica showing the top rectangle and sloping edges marked by black bands.

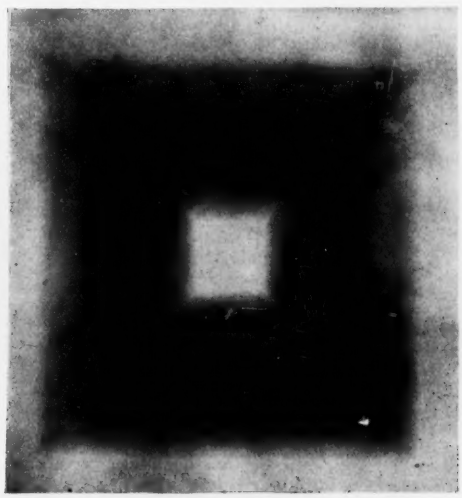

FIGURE 257.
From hollow pyramidal model of wax showing black bands along the top squares and outside sloping edges, white bands at the base and interior edges.

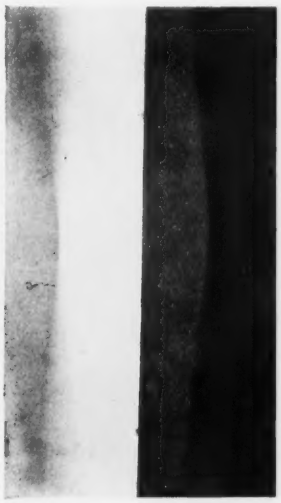

FIGURE 258.
From fan of ebonite showing broad black and white bands at top and bottom step.

FIGURE 259.
From triangular model of paper-strips, superimposed stepwise, showing black and white triangles and the bands produced in both directions showing through the layers above.

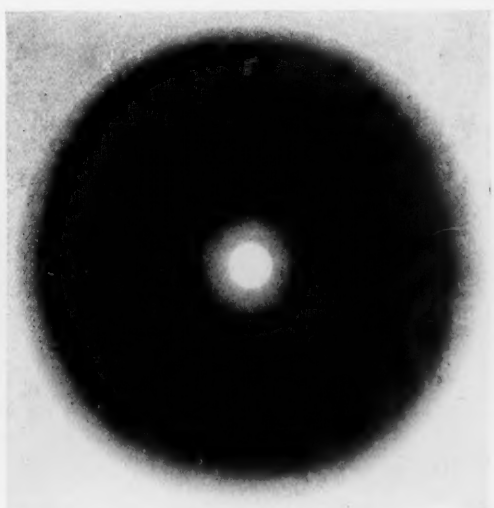

FIGURE 260.
From "well" of ebonite showing two white rings at the rim-edges. There is a broad black ring at the base.

Note.—As the Figures are from radiographs, the blacks and whites are reversed.

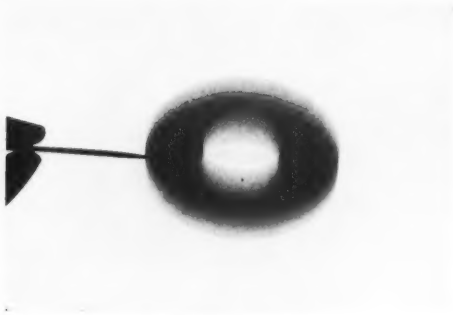

FIGURE 261.

Plate normal to rays, alternating semi-ellipses.

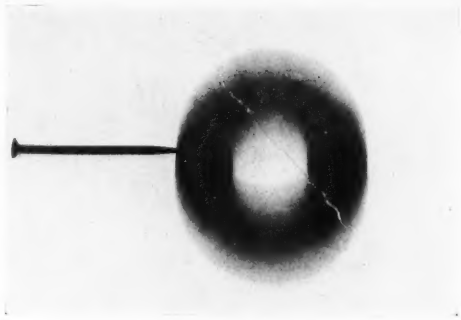

FIGURE 262.

Plate parallel to ring, alternating semicircles.

From an ebonite ring of rectangular cross-section. Rays incident at 45°.

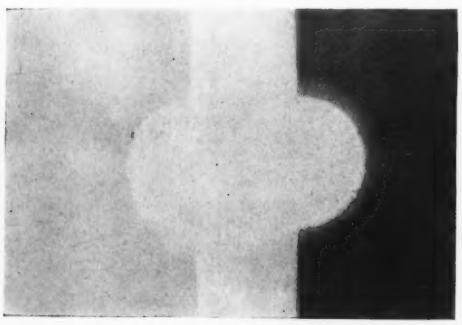

FIGURE 263.

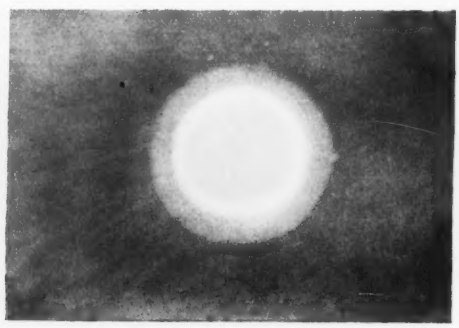

FIGURE 264.

From a conical well, made of paper, showing a black ring at the bottom and white ring at the top.

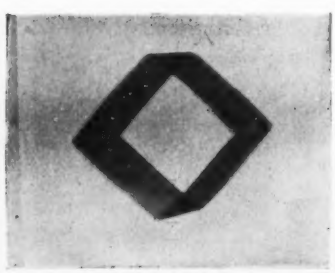

FIGURE 265.

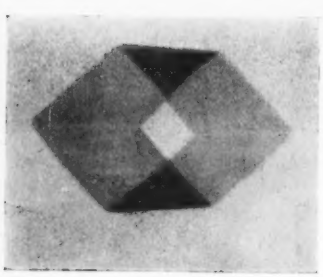

FIGURE 266.

From cylindrical model of sheet aluminium (·05 mm. thick) showing white bands at the edge towards reader.

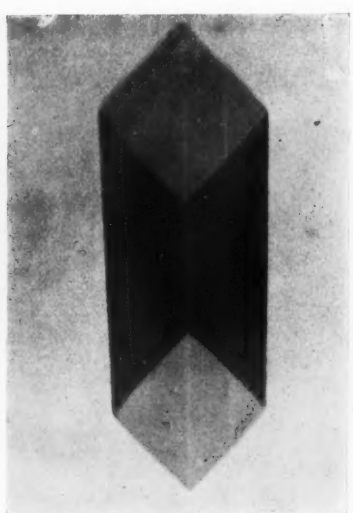

FIGURE 267.

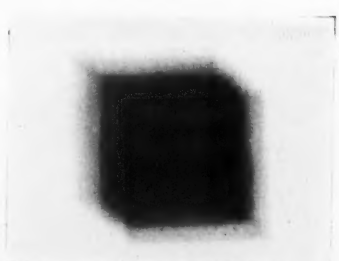

FIGURE 268.

FIGURE 269.

From rhomb of glass with 56 laminae.

NOTE.—As the Figures are from radiographs, the blacks and whites are reversed.

Moorhouse comet, Eddington), if, indeed, the latter be not a mere residual or differential of two forces of infinite potential powers. They might thus be responsible for the ubiquitous tendency to rotation and "spirality" which we observe in nature. That the Newtonian mechanics require extension is now almost universally admitted; but even when it is stretched to the uttermost to conceive of mass variable with internal energy and *vis a tergo* acting along helical lines of force, it is difficult to see how it can conduct the human mind to infinity beyond its reach.

In the earlier experiments (on single laminae) a bulb having a very fine focus was used, definition being of great importance. The present results were obtained with a large water-cooled Müller tube, with a platinised nickel anticathode. The current was kept constant by means of variable resistance in the primary, 1 to 1·5 milliamperes being commonly used.

Since the above article was written, it has been brought to our notice that the black band near bodies was observed as early as 1896 by the President of the Röntgen Society (Professor Porter) and Mr. Morris. The importance of this was lost sight of in consequence of the work with shields by Haga and Wind and others, which were supposed to be conclusive against refraction. *Ordinary* refraction, or diffraction, the effect certainly is not. Upon the hypothesis of a medium, such as aether, composed either of spent electrons, or as a continuous and very dense stratum near bodies, it is to be noted that the present is not an effect of *internal* action of matter upon bound aether, but is external to matter. In fact, it is evidence such as the experiments on aether drug (Mitchelson, Morley, Lodge) were designed to obtain, but without result. Moreover, these effects cannot be attributed to internal reflection, as suggested by Friedrich and Porter, since this would give opposite effects to those now obtained, viz., the black bands would appear *within* the shadow.

In a more recent experiment we have shown that the black band can be *separated* from the white in such a way that the two half-hoops of a ring (ebonite, with *rectangular* cross-section) show as white and black *semicircles*. This is true for all positions of the ring except the limiting angles, *i.e.*, 90° and 0°, and is highly significant of the fundamental duality of the rays, especially when taken in connexion with the fact that electroscopic tests for the black bands have given a 7 ± 2 increase over the normal radiation from the same aperture ·3 millimetre in width (see Figures 261 and 262).

The models and negatives actually used were exhibited at the Annual General Meeting of the Röntgen Society on June 9th, and can be seen by appointment at any time on application to the Medical Supply Association, Gray's Inn Road.

THE COMING ECLIPSE AND ITS PREDECESSORS.

As astronomers are taking so much interest in the coming total solar eclipse of August 20th to 21st next, it may be of interest to know that by the end of the present century this series or family of eclipses will entirely run out, that is, will cease to produce total eclipses; the last total eclipse taking place on October 3rd, 1986, which will be the fourth return of the one of August 21st next. The first total eclipse of this series took place on June 11th, 1211, and was visible in the southern hemisphere. The enclosed computation of the same is by the method of the late Professor Newcomb, in his work on "Recurrence of Solar Eclipses." I have computed the track of central eclipse of all of the eclipses of this series, from the one of next August to the last one of October 3rd, 1986. Within the last hundred years or more there have been many fine eclipses (all descending node) of this series. The total eclipse of June 16th, 1806, which was visible in the United States, was total in New York State and Northern New England. Dr. Nathaniel Bowditch, translator of Laplace's "Mécanique Céleste," observed it at Salem. He did not mention the prominences and scarcely mentioned the corona. He merely says: "The whole of the Moon was then seen surrounded by a luminous appearance of considerable extent, such as has generally been taken notice of in total eclipses of the Sun." The total eclipse of July 8th, 1842, one of the most famous ones of the past century, belongs to this series. Mrs. Todd, in her interesting little book on "Total Eclipses of the Sun," says of this eclipse: "While the eclipse of 1842 marks the dawn of a golden age in physical research upon the Sun, investigation proceeded slowly." From 1842 to the present time eclipses have contributed more to the physical side than to astronomy of precision. The next return of this series was the eclipse of July 18th, 1860. It was at the time of this eclipse that De La Rue demonstrated that the prominences were solar in their origin. The next return took place on July 29th, 1878. This eclipse attracted the attention of astronomers all over the United States. The Moon's shadow entered the United States in Washington Territory and Oregon, travelled south-east over Yellowstone Park, Wyoming, Colorado, into Texas, and left the Earth in the Gulf of Mexico near the West Florida coast. The writer observed this eclipse from Fort Worth, Texas, he being a member of a party of five who journeyed there for the special purpose. The other members of the party were: Dr. Leonard Waldo, then of the Harvard College Observatory; Professor Robert W. Willson, then and now of Harvard College; Professor J. K. Rees, then of Washington University, St. Louis; and Mr. W. H. Pulrifer, of St. Louis. The writer observed the reversion of the Fraunhofer lines at the instant of totality, and saw and measured the position of the 1474 line in the yellow-green part of the spectrum. Dr. Waldo had charge of the photographic work. Professor Rees observed with a three-prism spectroscope, and Professors Willson and Pulrifer did visual telescopic work. Clear skies favoured all of the observing parties on the central line from Oregon to Texas on that day. This eclipse took place during a minimum period of sunspots, and the regular type of corona was seen at that time. The next return took place August 9th, 1896, visible mostly in Northern Europe, and many of the observers were defeated by clouds and generally bad weather. The next return will bring us to the eclipse of August 21st this year. This should be a most interesting eclipse, especially so now as we are, apparently, very near the end of a very long and drawn-out period of minimum sunspots.

BOSTON, U.S.A. F. E. SEAGRAVE.

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NOTES.

ASTRONOMY.

By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S.

Professor Lowell was present at the May meeting of the British Astronomical Association, and gave some further particulars of his recent researches on the rotation period of Mars. He showed that the observations of the last century agree well with his new value of $24^h\ 37^m\ 22^s{\cdot}57$. The larger values previously accepted rest mainly on the sketches of Hooke and Huyghens in the seventeenth century. It would appear that too much weight has hitherto been given to these, in view of the very inferior instruments of that date and the inexperience of the observers in planetary delineation. It will be remembered that Mr. R. A. Proctor, the founder of this journal, contended strongly for the value $22^s{\cdot}72$, but he would probably now admit, in the face of the cumulative evidence, that this value must be too great.

Professor Lowell also observed that the experiment had been made of viewing Mars with the new forty-inch reflector (which was designed, not for planetary, but for stellar work), and that at moments of the best definition the network of streaks could be seen under the same aspect as with the twenty-four-inch refractor. Both he and Professor Pickering agree that a very large aperture can only be used with advantage for planetary work when the atmospheric conditions are practically perfect.

Much work has also been done on Saturn at Flagstaff. The variability of several of the satellites has been measured; the period of rotation appears to be the same in all cases as that of revolution, so that our Moon is not singular in this respect. Small corrections to the distance and motion of Mimas and Enceladus were found, and the existence of several faint divisions in the rings was verified, including that of Encke. The positions of these gaps were found to correspond with periodic times of revolution synchronous with that of Mimas; they are analogous to the gaps in the asteroid zone at points where the period is a simple fraction of that of Jupiter.

Professor Lowell also stated that they had been able to observe Venus fully illuminated within a few degrees of the Sun, and that the observations supported the identity of its periods of rotation and revolution. He considered that the high albedo arose, not from cloud, but from minute dust particles in suspension, which would give a still higher albedo than cloud, but would at the same time act as a veil rendering it very difficult to see the surface details. I may note that some recent observations by members of the Société Astronomique Française, reported in their Bulletin, also support the slow rotation of Venus.

Work is also being done at Flagstaff on the photography of the spectra of nebulae. Allusion has already been made in these columns to the continuous spectrum of the Merope nebula in the Pleiades and the great radial velocity found for the Andromeda nebula. Professor Lowell told us that he had just heard by telegram of the detection of rotational movement in a nebula in Virgo. He supposed this to mean a well-known planetary nebula that presents some resemblance to the figure of Saturn; but further details on that point and on the nature of the evidence of rotation will be sent by mail. Work on the spectra of planetary nebulae is also being carried on by Professor Wolf at Heidelberg, and he received the gold medal of the R.A.S. last February for this and other work. Some of his exposures extend to seventy-two hours, and he also has found evidence of high radial velocity in some of the nebulae examined, which, if verified, supports the idea that they are external universes.

COMETS.—Delavan's Comet has been hidden in the Sun's rays since April, but may be expected to emerge towards the middle of July. Mr. F. E. Seagrave has computed the following orbit: Perihelion passage, 1914, October 26·6731 G.M.T.; Omega, 97° 26′ 31″; Node, 59° 9′ 33″; Inclination, 68° 7′ 35″; Log. perihelion distance, 0·04375. The following ephemeris is for Greenwich midnight:—

Date.	R.A. h. m. s.	N.Dec. ° ′	Log. r.	Log.Δ.
July 22	5 36 40 ...	35 42 ...	0·2676 ...	0·4106
,, 30	5 58 36 ...	38 18 ...	0·2457 ...	0·3837
Aug. 7	6 24 0 ...	40 59 ...	0·2236 ...	0·3553
,, 15	6 54 24 ...	43 44 ...	0·2005 ...	0·3257
,, 23	7 31 14 ...	46 22 ...	0·1770 ...	0·2958
,, 31	8 15 43 ...	48 35 ...	0·1534 ...	0·2669

On July 29th the comet will be near Theta Aurigae; it will remain in Auriga till mid-August, when it will enter Lynx. It will then be above the horizon all night, but the best time for observation will be two or three hours before sunrise. In September it will traverse Ursa Major, and in October Boötes. It is difficult to give a prediction of its brightness, but I anticipate that it will become faintly visible to the naked eye in September. Its large perihelion distance is the only reason for doubt as to its becoming a fine comet; but the case of the great comet of 1811 shows that this is not an insuperable objection. Professor Pickering has pointed out that its orbit belongs to the class which he designates by the letter "Q," a class to which many conspicuous comets have belonged.

PROFESSOR BARNARD'S OBSERVATIONS OF NOVAE.—Professor Barnard has published another set of interesting notes on the Novae of recent years observed with the Yerkes Refractor. Last October he found that Nova Geminorum 2 (Enebo) had a focus of five or six millimetres greater than normal; but in January and February of this year the focus had returned to normal, and the aspect was that of an ordinary white star; it was one and a quarter magnitude brighter than the faint star 12″ north of it. The great Perseus Nova of 1901 underwent similar changes. The focus is now normal, and it appears like an ordinary white star, getting very slowly fainter. Last February its magnitude was 12·4. Nova Geminorum 1 (Turner, 1903) was of magnitude 16·8 last February. It is still fading slowly, but Professor Barnard expects that it will be visible in the forty-inch for at least another year.

EXTRACT FROM A LETTER ON COMETS BY M. FÉLIX DE ROY (Honorary Secretary Astronomical Society of Antwerp). — "Next December it enters the southern sky, and rapidly recedes from Earth and Sun, becoming invisible for the northern observers. If the comet does not brighten unusually, it will just be visible to the naked eye in October next, and the probability is that its apparition will not be a startling one. The curious fact with this comet, as pointed out by M. van Biesbroeck, is, however, that it is one of the cometary bodies with the largest *intrinsic brilliancy* as yet observed. In December last its magnitude was 10·7, and it could be observed in a small telescope. It was then at the distance 3·6 of the Sun (distance 1 = radius of Earth's orbit). At this same distance Halley's Comet was 16·3, and could only be observed with the most powerful photographical reflectors. The *unit magnitude* of Comet Delavan (as seen at distance 1 from Sun and Earth) is 5, and, since ten years, only four comets showed an equal or a greater proper brilliancy, *i.e.*:

1910.	(*a*)	Johannesburg ...	4	magnitude.
1904.	(*a*)	Brooks	5·0	,,
1911.	(*g*)	Beljawski	5	,,
1912.	(*a*)	Gale...	5·0	,,

For Halley's Comet this intrinsic brilliancy was only 10, for Morehouse's Comet (1908 *c*) 6·2, for Westphal's Comet (1913 *d*) 8·7. If Delavan's Comet does not become

unusually or irregularly fainter, its magnitude will be as follows :—

Date.	Distance from Sun.	Magnitude.
1916, July 1	 7	..... 12·9
1917, „ 1	 10	..... 14·7
1918, „ 1	 12	..... 15·5
1919, „ 1	 14	..... 16·2

One can therefore expect that this comet may be still observed with the great Cape reflector as late as the summer months of 1919. It will then wander at one thousand three hundred and one million miles from the Sun, and, if an observation may be thus obtained, Comet Delavan *will have been observed in seven consecutive years*, an unusual, and perhaps unique, feature in observational astronomy."

I would remark that the writer of this interesting note does not seem to have allowed sufficiently for physical change when the comet approaches perihelion. I shall be surprised if it does not become brighter than the sixth magnitude.

Another naked-eye comet was discovered in mid-May by M. Zlatinsky at Mitau, near Riga : it was for a few days a conspicuous object in the evening sky, but it soon ran to the south, and is now out of our reach. Its orbit resembled those of 1790 III (Caroline Herschel) and Quenisset's of 1911 ; it thus offers another example of a family of comets having almost identical orbits.

Kritzinger's Comet has also been an easy telescopic object in May and June, and may still be visible during July, being of the ninth magnitude. The following ephemeris is for Berlin midnight :—

Date.	R.A. h m s	N.Dec. ° ′	Log. r.	Log. Δ.
July 1	22 14 36	... 44 45	... 0·1043	... 9·8185
„ 9	22 28 20	... 44 4	... 0·1199	... 9·8332
„ 17	22 37 52	... 42 48	... 0·1377	... 9·8456
„ 25	22 43 40	... 41 0	... 0·1568	... 9·8562

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

DROUGHT RESISTANCE IN FERNS.—Two interesting papers have been published recently on the adaptations of various ferns to resist drought. Ferns as a class are, with conspicuous exceptions like the bracken, confined to shaded and moist habitats, but where necessary they may show marked adaptations for life in places where the water supply is scanty or liable to great changes. Schaede (*Beitr. zur Biol. d. Pflanzen*, Bd. 11) points out that, while in a general way the methods adopted to secure protection against strong insolation and transpiration are much the same among ferns as in flowering plants, xerophilous ferns present certain features of special interest. The most striking of these are rolling up of the leaflets and leaf-stalks during drought, and the possession (usually in addition to rolling) of a covering of scales or of wax on the lower side of the leaves. Several xerophilous ferns from various parts of the world were investigated, and some common European species were used for comparison in the experiments made. The scale-covered forms investigated were species of *Ceterach* and *Notochlaena*. The scales were found to act largely by reflecting a considerable portion of the incident light, part of which was absorbed by the brown pigment of the scales, so that in cases where the scales are well developed and closely overlap each other very little of the incident light passes through this covering. In *Notochlaena sinuata* the overlapping whitish scales are mingled with much-branched hairs forming a dense felting. The wax-covered forms examined were Mexican species of *Notochlaena*, *Cheilanthes*, and *Ceropteris*. The wax is secreted by hairs covering the lower surface of the leaves, and forms a coherent covering joining the tips of the hairs in such a manner as to form a membranous canopy, and thus produce an air-still chamber below the leaf—a very effective method of checking transpiration. In *Ceropteris calomelanos* the leaflets do not become rolled up as in the other species with waxy covering, but each leaflet is inserted on the petiole by a broad base, which is decurrent on the petiole, so that the latter has a kind of wing on either side corresponding with the two rows of leaflets, and the cells of the wings are contractile, so that during drought the two rows of leaflets become folded together with their waxy under-surfaces outwards. In the other forms investigated the leaflets simply undergo changes in form. In most cases this consists in an irregular crumpling and folding in the long axis of the leaflet between the veins, the result being that the convex sides of the folds are on the upper side of the leaflet. In *Asplenium septentrionale* each leaflet assumes the form of a spirally wound ribbon, in *Actiniopteris radiata* that of a completely closed tube ; in both cases the whole leaf also curves so that the leaflets are placed parallel with the incident light-rays.

Pickett (*Bull. Torrey Bot. Club*, Volume 40) points out that little is known regarding drought-resistance in fern prothalli. The form dealt with, *Camptosorus rhizophyllus*, grows usually on the surface of dry limestone ledges and on detached rocks in stream beds, and since these places are without constant water supply the plants are subjected to brief periods of abundant moisture (during and immediately after rain), which alternate with longer drought periods ; hence it becomes a question how plants with a delicate prothallial stage in their life-cycle can secure and retain residence under such conditions. Cultures of mature spores were made, with a view to obtaining information regarding the uniformity of spore germination and prothallial development, the ability of prothalli to resist or survive natural drought conditions, and the ability to survive conditions leading to complete desiccation. The spores of this fern were found to germinate very irregularly, and to have a long, dormant period on the moist soil of cultures, suggesting that they might remain in this condition through the winter season in their natural habitat. Experiments in which prothalli were subjected to dry air without direct sunlight — continuous conditions approximating the average of varying conditions found in nature— showed that the production of mature prothalli under such conditions was possible ; while the subjection of prothalli to more thorough desiccation over sulphuric acid, and so on, showed the possibility of surviving the extreme conditions found in nature. The author concludes that the drought-resisting character of the prothalli is doubtless a very effective factor in the adaptation of this fern to its habitat.

PLANKTON (VEGETABLE) OF THE ENGLISH CHANNEL.—Mangin (*Rec. Jub. Sci. du Prof. Le Monnier*, 1913) describes plankton observations made between 1908 and 1912 in the waters near Tatihou on the coast of the Manche peninsula (North-western France) ; since the depths are very slight (only fifteen to twenty metres) surface plankton alone is dealt with. The volume of the plankton was always smallest in winter, but increases in March and attains a first maximum in May or June, and a second more important maximum in October and November. The plankton is distinguished by great abundance of Diatoms, Peridineae being scarce ; between May and August it is homogeneous, and made up of few species, while during the rest of the year it is heterogeneous and varied. The distribution of the dominant species is indicated by a series of diagrams showing the average dates of their appearance, dominance, and disappearance. Of the forty-five Diatom species found thirty are widely distributed neritic forms in temperate regions, and the remainder Arctic forms. The term " neritic " is applied to organisms found in shallow or inshore waters as compared with those of the open deep sea (" pelagic," or " oceanic "). In discussing the relations between the phytoplankton of Saint-Vaast and that of neighbouring regions, the author points out that

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from observations made on the opposite sides of the English Channel—off Manche and off Plymouth—one might infer that oceanic species would be continually driven by the currents entering the Channel on to the south coast of England from Land's End to Newhaven, and that the peninsula of Manche would shelter Saint-Vaast (on the eastern side of that peninsula) from this invasion. On the other hand, currents proceeding from the North Sea and impinging on the French coast would extend as far as the Seine Bay, and bring to this region a larger proportion of boreal and Arctic species than would reach Plymouth, some of these species eventually becoming endemic forms. The phytoplankton of Saint-Vaast is thus of a neritic type, sheltered from the invasion of Atlantic forms and open to that of Arctic or boreal forms, some of the latter having become endemic, and thus added to the typical neritic forms of temperate waters.

CHEMISTRY.

C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

THE NITROGEN AND CHLORINE IN RAIN AND SNOW.—Mr. G. H. Wiesner examined twenty-two samples of rain-water and nine of snow, which fell between February and June, 1912, at Mount Vernon, in the United States. The place was a small village, with a population of one thousand seven hundred, and had no manufacturing industries. The average results obtained in the estimation of the nitrogen and chlorine, which have recently been published in *The Chemical News* (1914, CIX, 85), were as follows :—

PARTS PER MILLION.

——	Snow.	Rain.
Free Ammonia ...	3·35	0·931
Albuminoid Ammonia ...	3·84	1·13
Nitrite Nitrogen ...	0·0021	0·0018
Nitrate Nitrogen ...	0·19	0·15
Chlorine	4·7	4·8

It is mentioned that during the period selected the rainfall was fifteen inches and the snowfall twenty-four inches, which was equivalent to two inches of rain. This was higher than the average rainfall for the district.

DISTRIBUTION OF ALUMINIUM IN THE VEGETABLE KINGDOM.—A micro-chemical test for aluminium has been devised by Dr. E. Kratzmann (*Pharm. Post*, 1914, XLVII, 101), and is capable of detecting traces of aluminium in plant-ash and in the sections of plants. It is based upon the fact that on treating an aluminium salt with a solution of caesium chloride and dilute sulphuric acid characteristic crystals of a double salt of caesium and aluminium sulphate are obtained within a few minutes.

By applying the test under the microscope the aluminium crystals may be seen *in situ* in the sections of plants, and it has been shown in this way that aluminium is widely distributed in the vegetable world. Certain plants, such as, for example, *Lycopodium*, *Vitis*, *Symplocos*, and *Anchusa* in particular, are remarkably rich in the element. The so-called "alumina bodies," which have been described as present in the leaves of plants of the *Symplocos* species, were only found by this test in the leaves of *S. polystachya* and *S. lanceolata*.

THE ACTIVE MODIFICATION OF NITROGEN.—Messrs. H. B. Baker and R. J. Strutt have published further experiments which show that the "after-glow that characterises the active modification of nitrogen is not due, as was asserted by Messrs. Tiede and Domcke, to the presence of traces of oxygen (*Ber. d. deut. Chem. Ges.*, 1914, XLVII, 801 and 1049). Thus they have found that nitrogen from which every trace of oxygen had been eliminated still showed the phenomenon, as did also the nitrogen prepared from potassium azide. Moreover, contrary to the statement of Tiede and Domcke, commercial nitrogen from a cylinder remained "active" after having been passed over copper heated to 400° C. to remove any residual oxygen. As a further proof that "active" nitrogen is a distinct modification of the element, there is the fact that it enters into combination with other substances. For example, it acts upon different metals, such as mercury, to form nitrides; while it decomposes certain organic compounds, with the formation of hydrogen cyanide. These results confirm the conclusion of Messrs. Koenig and Elöd, an outline of which has already appeared in these columns.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

RECRYSTALLISATION OF DEFORMED IRON.—The results of an experimental investigation of this subject by Mr. C. Chappell were given in a paper read before the Iron and Steel Institute. Samples of practically carbonless iron were pulled to fracture in a tensile-testing machine, and others had indentations made in them by means of a hardened steel needle actuated by a Brinell hardness-testing machine. The deformed samples were then annealed at different temperatures, and the alteration in the crystalline structure of the metal, as affected by the two variables, degree of deformation and temperature of annealing, studied. Two distinct resulting zones were observed. The first, that of maximum deformation, yielded new crystals not markedly different in size from those of the original material previous to deformation. The original crystals disintegrated and the new crystals grew from the *débris*. The second (outer) zone, in which plastic deformation had taken place to a less extent than in the first zone, was characterised by an enormous increase in crystal size. As regards the temperature of recrystallisation, it was found that the more highly deformed parts recrystallised at lower temperatures than those parts which had suffered less deformation. The examination of cold-drawn wires showed that the deformation produced in ordinary wire-drawing operations corresponds to that of the first zone described above. Attempts were made to obtain coarsening of crystals on annealing less severely cold-drawn wires, which might be considered analogous to the less-deformed outer zone, but were in all cases unsuccessful.

THE COLOUR OF METALS AND ALLOYS.—In an article in *The Chemical World* for May, 1914, Messrs. F. C. Thompson and E. Sinkinson describe a method by which numerical values for the colours of metals may be obtained. The metal sample is polished with emery, and is then photographed through a blue glass screen. The time of exposure, time of development of the plate, temperature of the developer, and all other conditions must be reproduced exactly in order to obtain comparable results. The density of the resulting negative is measured in a Sanger-Shepherd densometer, and the result calculated to a scale in which the colour value for silver is 0, and that of copper is 50. The results obtained by the authors show that an increase of coloration in the metal does give a higher "colour figure," but the method can detect no difference between pure and "standard" silver (silver 92·5 per cent., copper 7·5 per cent.), and is only just sufficiently sensitive to distinguish between German silvers having respectively fifteen and seven per cent. of nickel.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

PERMANENCE OF THE ATLANTIC COASTLINE.—Professor J. Welsch contributes an interesting study of the coastal border of South-western France to the May issue of the *Annales de Géographie*. The section discussed extends from about the river Sèvre to Biarritz. On this coastal

stretch numerous phenomena have been recorded as indicating an alteration of the relative levels of land and sea. Professor Welsch reëxamines such and similar evidence in order to decide whether the coastline has altered within recent time. He dates this " recent " period from the close of the Palaeolithic and before the beginning of the Neolithic.

For the most part the evidence is of the usual nature—raised beaches, old sea cliffs, and submerged peat beds and forests. Many of these, however, are of an older date, Pliocene and Pleistocene. But conclusions regarding the later period with which the paper deals have been drawn indiscriminately from them, and some sifting of the evidence is necessary. When the older remains have been put on one side Professor Welsch finds it possible to explain the facts without reference to uplift or depression of the land. It has been held that in some cases purely local movements of considerable amplitude in both senses have taken place. Such movements are both unnecessary and highly improbable. Much can be explained by supposing that protecting dunes and banks which once held up fresh and brackish lagoons have been removed by marine erosion. Such processes of erosion can be seen to be in progress with similar consequences at the present day. Shifting drifts of sand have exposed old smothered forests in France as they have done in Scotland, and young forests are seen growing on the sand and mingling with the old. There is no proof, it is held, of submersion or of emergence of the land since the Neolithic began, while in the period immediately anterior movements and dislocations certainly took place.

An interesting phenomenon discussed in the paper is the presence of great mounds of oyster-shells at Chauds in Vendée, Les Buttes de Saint-Michel-en-l'Herm. These lie on late marine deposits, rising two or three metres above sea-level, and attain a height of eleven metres. The " buttes " are three in number, elongated rounded hillocks, extending over ·8 kilometre. The true thickness of the deposits cannot be ascertained, but the mounds have been breached to get shells for lime, and are seen to consist almost entirely of oyster-shells with little or no sand or grit and rare shells of other species and genera. These shell banks are different from any that have been described elsewhere on the Continent. The shells composing them have the peculiarity that often the two valves are joined. The mounds cannot therefore be regarded as kitchen-middens, nor are they natural deposits. They are probably the work of man, possibly relics of religious significance like others in the plateaux of Algeria and in America.

THE SEA ROUTE TO SIBERIA.—The development of Siberia, which for a long time was slow, but has quickened of late, promises to be an interesting subject. Minerals, timber, and, above all, agriculture promise to be its most valuable resources, but so far they are almost untouched. Trapping is the only industry carried on in Siberia to supply Western markets. Of recent years the Russian Government has adopted a more liberal and enlightened policy, and in each of the last two years the number of immigrants has been about three hundred thousand. Jonas Lied writes in the May *Geographical Journal* on the resources and development of Siberia, and the article makes fascinating reading. It is followed by a second, by Dr. Nansen, on the possibility of a sea route through the Arctic Ocean. A passage was actually made by the Kara Strait in a " tramp " steamer last autumn, Lied and Nansen being on board.

The navigability of the route seems to vary in different seasons, but to be dependent on circumstances easily determinable. Cold, dry years tend to be followed by close winters and autumns, and mild or moist years by open seasons. Nansen believes that if continuous and systematic observations were made, the passage could be made almost every year, and intelligence of the position and movements of the ice supplied which would make the route practicable at favourable times even in bad years.

FEDERAL CAPITAL OF AUSTRALIA.—In the April and May numbers of the *Geographical Journal* readers will find a physiographic study of the new capital of Australia, Canberra, by Mr. G. Taylor. The article studies the topography of the selected area and discusses its evolution. The suitability of the site is exhibited, and the progress of work in the city is described.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

PILLOW-LAVAS IN THE ANDES.—An occurrence of pillow-lava with several unusual features is described by J. A. Douglas in a paper on " Geological Sections through the Andes of Peru and Bolivia " (*Quarterly Journal of the Geological Society*, April, 1914). It occurs in the Morro de Arica, and is interbedded with Jurassic shales. The pillow structure is first exhibited in a thick flow (one hundred and fifty feet) of enstatite-andesite. The spaces between the pillows are filled up with a black shale or mudstone containing an abundance of *Posidonomya escuttiana* Douglas, which continues for a few feet above the lava. It is succeeded by red, sandy, gypsiferous shales, above which further flows of pillow-lavas occur at several horizons. The whole thickness of the lavas exhibits pillow-structure, and the " pillows " are often more than ten feet in diameter. The lamellibranch shells, found in the black shale between the pillows, are often unbroken and well preserved, and the lava doubtless represents a submarine volcanic flow contemporaneous with the deposition of the shale. The rock differs essentially from many other occurrences of pillow-lava, in the almost complete absence of vesicular or amygdaloidal structures. Furthermore, it is very fresh, with a complete absence of the albitisation which occurs in the spilitic pillow-lavas, and its petrographic character is distinctly of a " Pacific " type. This occurrence adds one more, therefore, to the growing list of pillow-forming rock-types, in addition to the typical spilites.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

CONNECTION BETWEEN THE SUMMER RAINFALL AT HAVANA AND THE WINTER RAINFALL IN THE SOUTH-WEST OF ENGLAND.—At the meeting of the Royal Meteorological Society on May 20th Mr. A. Hampton Brown read a paper on " A Cuban Rain Record and its Application," in which he dealt with the rainfall records of the Belen College Observatory, Havana, for the period 1859 to 1912, and gave particulars of the monthly, yearly, and seasonal rainfall. The average yearly rainfall for the fifty years 1861–1910 is just under fifty inches; but during the past fifteen years there has been a marked tendency to diminished amounts. March is the driest month, with 1·91 inches, and October the wettest, with 6·92 inches, followed closely by June with 6·71 inches. The most phenomenal month was April, 1869, when 22·57 inches was recorded, falling on six days. On the other hand, April, 1896, was entirely rainless. The rainfall year can be divided into two seasons—a wet season from May to October, and a dry season from November to April. During the former 35·36 inches, or seventy-one per cent., of the rain falls, the remaining 14·60 inches, or twenty-nine per cent., being recorded in the dry months. The author has endeavoured to trace the connection between the wet season at Havana during May to October and the precipitation in South-west England and South Wales during the three months January to March following, and he has found that from 1878 onwards, when the first reports for this country are available, an excess rainfall in Havana during May to October was generally followed by a deficient rainfall in South-west England at the beginning of the next year, and *vice versa*. For the eight years 1888–1895, when the rainfall at Havana was continuously in excess, in South-west England the figures with one exception were the reverse.

XUM

During the next five years, 1896–1900, there was a deficiency at the Cuban station, and, excepting 1897, an excess in this country. There were many years when the application failed, but the general continuance of the see-saw movement was so persistent that it could hardly be regarded as merely coincidental. The author suggested that the cause of the connection was possibly due to the interaction of the trade winds, the Gulf Stream flow, and the Labrador Current, and thought that if a more definite knowledge of the movements of these were obtained it might be possible in conjunction with the Havana rainfall to work a fair approximation of the probable rainfall for South-west England and South Wales for the first three months of the year.

EFFECT OF THE GULF STREAM ON OUR CLIMATE.—Commander M. W. Campbell Hepworth, at a recent meeting of the Royal Geographical Society, read a paper on the "Gulf Stream," in which he expressed the belief that the warm, relatively high salinity water which undoubtedly exercises an ameliorating effect upon the climate of our islands and upon that of North-western Europe generally is mainly of equatorial origin, and is directly attributable to the agency of the Gulf Stream. He pointed out that air temperature over these islands is modified by changes in the surface temperature in at least three ways: (1) By winds that come from seaward; (2) by the influence of sea temperature upon the course taken by low-pressure wind systems which pass over or near them; and (3) by a diminution of cloudiness.

The temperature of the air is soon modified by the temperature of the surface water over which it passes. When the surface temperature of the north-eastern arm of the North Atlantic is much below the normal, atmospheric pressure over the Iceland-Faroe region has a tendency to increase, and the centres of depressions visiting North-western Europe to be diverted to a more easterly direction, and to pass directly over the British Isles or not far north, and at times even south of their coasts, bringing to our islands much cloudiness and rain. On the other hand, during seasons in which the warm stream extends as far to the north-eastward as its average limits, or still farther north, depressions travelling eastward and north-eastward from the Atlantic pursue paths which take their centres to the north-westward of our western and northern shores, with the result that a mild or comparatively mild type of weather conditions, accompanied by more or less sunshine, prevail.

The association of bright, warm weather in summer with sea temperature above the normal may perhaps be accounted for by the small difference obtaining between the temperature of the air and that of the surrounding sea, the consequent diminution of cloudiness, and corresponding increase of sunshine. In that season, moreover, a diminution even in the quantity of vapour in the atmosphere during the day and following night is attended by a rise in the mean temperature of the twenty-four hours, because the heat the Earth receives by solar radiation exceeds that which it parts with by terrestrial radiation.

Commander Hepworth in conclusion said that "proof may be claimed, resting on a chain of evidence, that many of the climatic changes to which our islands are subject, owe their origin to modifications in the trade winds of the Atlantic, communicated through the agency of the equatorial currents, and its giant offspring, the Gulf Stream."

INFLUENCE OF DUST STORMS ON THE ATMOSPHERIC POTENTIAL GRADIENT.—Mr. W. A. D. Rudge during the past three years has carried out observations at Bloemfontein in the Orange Free State on the daily range of the atmospheric potential gradient. These observations on the high veld show that considerable variations may occur as a consequence of the presence of dust in the atmosphere. The effect of the siliceous dust of South Africa is to lower the normal positive gradient, and, if present in sufficient amount, to reverse it. Wind unaccompanied by dust has very little influence on the normal charge in the atmosphere. The rain which fell during the period under special observation (July to December, 1912) was invariably charged negatively.

MICROSCOPY.

By F.R.M.S.

I.—THE WATER-BEETLE (*DYTISCUS MARGINALIS*). (*Continued from page* 225.)—The spiracles, or breathing-pores, of the Water-beetle are found as oval slits on each segment of the body. These openings have projections from the sides covered with very fine horizontal hairs: these fine hairs are dust-preventers, and serve to allow only clean air to enter the spiracle (see Figure 270). The last pair of spiracles, situated near the tail-end of the abdomen, are unusually large, and can be opened or closed by the insect at will.

The Water-beetle in want of air rises to the surface of the pool and sticks out its abdomen, and at the same time opens its wing-cases, or elytra, very slightly. Air is taken in by the abdominal spiracles or last pair, and also a supply is gathered under the wing-cases, which is held by the hairs on the back of the abdomen, and forms a large air-bubble.

The insect then plunges down from the surface, and the air under the wing-cases is passed forward to the front spiracles, and thus the beetle, in a state of enforced submergence, can remain under water a considerable period.

The wing-covers, or elytra, are very hard in substance, but very smooth surfaces are found in the male, whereas the female has furrowed wing-cases (see Figure 271). Under these wing-cases are laid the crumpled large wings, only used in flight through the air when the insect travels to a new pond, this being done in the twilight or during early morning.

The legs of the Water-beetle present several modifications and in the male (the fore-legs) this is very marked. The terminal parts form a large developed organ, having on its surface circular suckers and at the tip two small claws (see Figure 272).

Peculiarly, we can find these suckers are also present in the middle legs, but they are not circular, as in the case of those present in the fore-legs (see Figure 273). These circular discs (see Figure 272) have on the under-surface a number of minute stick-shaped projections, and the whole of the modification is fringed with hairs. The two large suckers, placed one on each side, are unequal in size, and specially carried on projecting stalks; each sucker is elastic, and consists of radiating ribs, which close up like an umbrella.

Under the large suckers are many smaller ones, and it has been calculated that in the male there are one hundred and seventy sucking hairs in each fore-leg, and one thousand five hundred and ninety in each middle leg. These suckers are very powerful, and a Water-beetle is difficult to remove if it is attached to a stone or stems of water-plants. The suckers are used chiefly in holding the female during mating periods, and sometimes for holding prey, such as tadpoles and young fish.

The hind-legs are very strong (see Figure 274), and are used solely for swimming purposes, as can be judged by the outline, which resembles an oar in shape. On each segment are present many hairs, which serve to gather water, and so propel the insect forward through the water.

W. HAROLD S. CHEAVIN, F.R.M.S.

INTELLIGENCE IN PARASITIC ROTIFERS. (*Continued from page* 191.)—(2) The second parasitic Rotifer which claims our attention is a fairly large species which has made a speciality of raiding, and living at the expense of, water-snails' eggs, considering, no doubt, that these have been specially provided by Nature for its own special benefit. *Proales gigantea* was first discovered in Ireland in 1892 by Miss Glascott, but was not

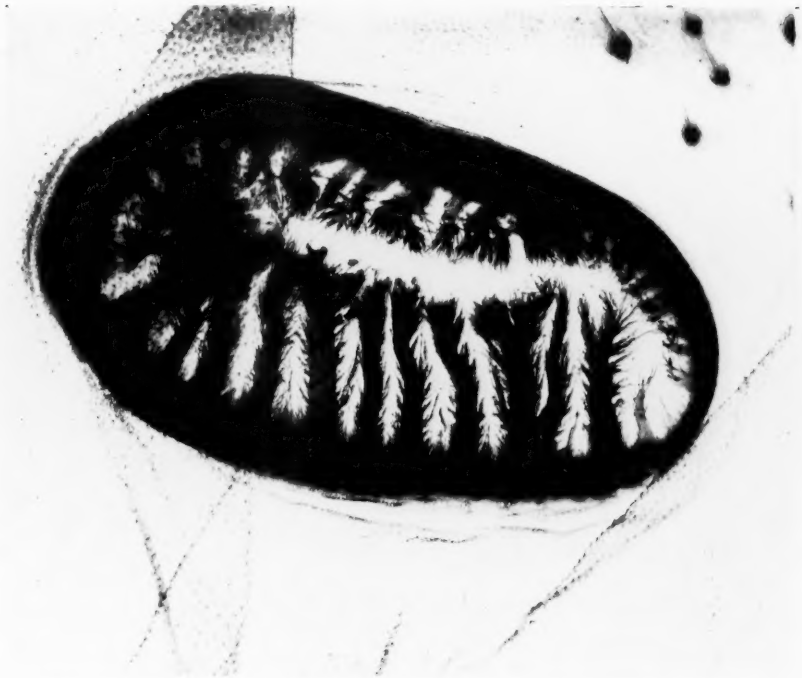

FIGURE 270. One of the posterior spiracles of the Water-beetle. × 60. The spiracles are the openings into the breathing tubes, or tracheae.

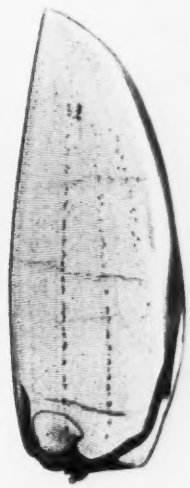

FIGURE 271. One of the elytra, or wing-cases, of a Water-beetle (*Colymbites fuscus*). × 36.

FIGURE 272. Fore leg of male Water-beetle with suckers. × 36.

FIGURE 273. Middle leg of male Water-beetle. × 6.

FIGURE 274. Hind or oar leg of male Water-beetle. × 6.

From a photograph *by Charles Reid.*

FIGURE 275. Wild Cats.

(From "Odd Hours with Nature," by Alexander Urquhart. By the courtesy of Mr. T. Fisher Unwin.) See page 276.

From a photograph *by R. Lunn.*

FIGURE 276. The Valley of the Thousand Hills, 5¼ miles S.W. of Kinlochewe, Ross-shire.

(From "The Quaternary Ice Age," by W. B. Wright. By the courtesy of Macmillan & Co.) See page 275.

seen again until the late Mr. John Stevens found it near Exeter in the summer of 1911, causing havoc amongst the eggs of his water-snails (*Limnea auricularia*). It is therefore either very rare or, which is more probable, has not been looked for in the particular habitat where it makes its home; it has never been found swimming about freely in the water, nor has it been reported from any other country. (An account by John Stevens of the life-history of this Rotifer will be found in the *Journal of the Quekett Microscopical Club*, Volume IX, 1912, pages 481–6.)

This Rotifer displays considerable intelligence in the ways and means it adopts to find and then penetrate to its victims. The water-snail's eggs are laid on submerged leaves of water-plants in clusters of one to two dozen, surrounded by a stiff and dense gelatinous substance, which effectively protects them from the predaceous aquatic larvae; but this Rotifer, on coming into contact with such cluster, appears to know that there is something desirable inside the insipid gelatine, and promptly sets to work to penetrate it by a process of pushing, twisting, rolling, and ever inverting and extending its extremities. When, after a good deal of work, an egg is reached inside the cluster, *Proales* finds that the egg-shell is very tough and resistant, and it takes two hours to nibble a very small hole and then push and wriggle itself through the opening in the same manner as has been previously described in the case of *Proales parasita* living in the spheres of *Volvox globator*.

Once inside the snail's egg the Rotifer feeds on the albuminous contents, then begins to nibble at the embryo snail, which, unconscious of the dangerous intruder, continues its slow and regular movements, ever revolving in the fluid contents of the egg. The Rotifer then lays an egg and continues this performance until twelve to fourteen have been laid in the course of three days, and these develop and begin to hatch on the fourth day. The parent then abandons its home for fresh fields, leaving its progeny to look after themselves, of which they are quite capable. The embryo snail, finding its food material disappearing, gets weaker and weaker, and finally dies and dissolves, being absorbed by the family of *Proales* within three to seven days. The young Rotifers leave the snail's egg in which they were born one by one through the opening made by their parent, and make their way through the gelatinous covering to other eggs of the same cluster, and begin the same process, so that very few of the young snails escape and succeed in coming to maturity.

The size of *Proales gigantea* is one fiftieth of an inch, which is large compared with other members of this genus. It possesses a single small red eye in the form of a lentil-shaped cushion of red pigment on which is seated a crystalline sphere measuring one seven thousand five hundredth of an inch in diameter. This eye is situated, as usual in Rotifers, on the brain, a small hyaline cluster of cells, which does all the thinking and guides this small creature in its search for snails' eggs, also devising the method and means by which it overcomes the considerable difficulties in getting inside them.

C. F. ROUSSELET.

(To be continued.)

THE QUEKETT MICROSCOPICAL CLUB.—At a meeting of the Quekett Microscopical Club, held on May 26th, Mr. A. E. Hilton read "Some Notes on the Cultivation of Plasmodia of *Badhamia utricularis*." In place of the fungus, *Stereum hirsutum*, recommended by Lister as the best food for this plasmodium, but which is not always easy to obtain, the author had found that a solution of ammonium phosphate (14 grammes), cane sugar (14 grammes) in water (1000 cubic centimetres) was a quite satisfactory substitute. Bread moistened with water and, occasionally, with the phosphate solution is also good. A method of observing the streaming movements is to allow a plasmodium to become dry on a piece of blotting-paper. A slip of this is taken and placed, as a ring, inside a test tube of suitable diameter. When moistened with water the plasmodium soon becomes active, and is conveniently examined through the walls of the tube. Mr. E. M. Nelson, F.R.M.S., contributed a paper on "Binocular Microscopes." The points gained by binocular vision are: (1) Stereoscopism, or the power of appreciating solidity; (2) Increase of apparent magnifying power; (3) Increase of illumination; (4) Increase of colour perception. The paper deals principally with the four forms of binocular recently introduced: The Greenough, by Zeiss, in 1897; the Ives, in 1902; and the Leitz and the Beck, within the last few months. In the Greenough all the four attributes of binocular vision are secured. The single objective binoculars may be divided into two kinds—those of the Wenham or Stephenson type, which split the beam at the back of the objective, and those of the Powell type, which pass the whole beam. This second class, however, does not possess true stereoscopism. Their use is confined to the employment of full Ramsden discs in each eye, and when prolonged work is undertaken with one of the new binoculars great relief and comfort to the eyes will be secured.

Both Messrs. Beck and Leitz exhibited stands illustrating points touched in Mr. Nelson's paper.

PHOTOGRAPHY.

By EDGAR SENIOR.

A NEW PHOTOGRAPHIC PRINTING PAPER—"SATISTA."—We have lately had an opportunity of trying the paper bearing this name, which has been issued by the Platinotype Company, of 22, Bloomsbury Square, W.C. The sensitive coating on the paper consists of a mixture of platinum and silver salts, but the final results that were obtained from the same negatives on the older platinum paper and this new variety so closely resembled each other that it was difficult to discover any difference between them. We may therefore say that the prints are identical in appearance with those in which the image consists of platinum only. Of course, as the image is partly composed of silver, doubts might be raised as to its equal permanency with those in platinum, but we are told that if the silver is removed by chemical means the platinum will still remain in sufficient quantity to form the picture, so that in that sense the image may be considered as permanent. But still, suppose this is not the case, even then the new paper will be a very valuable addition to the existing printing papers, because it will enable the photographer to produce prints having all the appearance and beauty of a platinum print at a much less cost, the price of a dozen pieces half-plate size costing only 1s. 3d., while at the same time the prints may be considered practically permanent. The printing and general appearance of the image during this operation are to all intents and purposes the same as in platinum printing generally, but the after-manipulations are somewhat different. Thus, the development is effected by immersing the exposed print face up for half a minute in the following solution:—

DEVELOPER FOR BLACK TONES.

Potassium Oxalate	8 ounces
Oxalic Acid	100 grains
Water (Distilled)	40 ounces

This solution will keep indefinitely, and should be used at a temperature of 60° F. After development, the prints are cleared by means of two baths composed of the acid oxalate of potash (salts of sorrel), allowing them to remain for ten minutes in each.

FORMULA FOR CLEARING SOLUTION.

Potassium Hydrogen Oxalate (Salts of Sorrel)	1½ ounces
Water (Distilled)	80 ounces

The prints, on removal from the second clearing bath, must be washed for ten minutes in running water, and this time should not be exceeded, otherwise a yellowing of the prints may result. The unaltered silver salts which the

prints still contain must then be removed by means of hypo, using a solution of the following strength :—

FIXING BATH.

Hypo	2 ounces
Water	20 „

The prints are to be allowed to remain in this bath for fifteen minutes, after which they must be washed for forty minutes in running water or repeated changes. If warm black tones are required, these may be obtained by the addition of a little mercuric chloride to the developer, and developing at a temperature of 140° F., while various shades of brown to red will result from toning the prints with uranium, a formula for which is given in the instructions issued with the paper.

PHOTOGRAPHING EMBRYOS.—In photographing these and other small specimens it is convenient to use a vertical camera with the lens attached to the front board of the camera in the usual manner: this is readily accomplished by means of adapters to take the micro-planars, or other objectives which it is desired to use. The degree of magnification employed is usually from one up to ten times; and, as in the cases already mentioned, the position of the ground glass for any given magnification is determined once and for all by the use of a scale in millimetres.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

SO-CALLED SENESCENCE OF INFUSORIANS.—It has been observed that stocks of Infusorians all descended from one individual by successive generations of asexual multiplication are apt to "give out." Senile, degenerate forms occur. This was attributed by Maupas and others to the absence of conjugation. It has been shown, however, that Infusorians are very sensitive to their old waste-products, and to certain peculiarities in the culture-medium. It has been found possible to stave off the senescence by giving tonics of beef-tea and the like. One of the most recent investigations, by Mr. George Alfred Baitsell, reports that conditions have been found in which *Pleurotricha lanceolata* will apparently thrive and multiply indefinitely without conjugation or artificial stimulation. An optimum environment has been discovered.

DECAPITATED YOUNG NECTURUS.—In the early summer of 1898 Professor A. C. Eycleshymer accidentally subjected a large number of Necturus larvae (ten to fifteen millimetres long) to violent agitation. Some of them, which had their heads broken off by the shaking, showed no disintegration, and lived for several weeks. Subsequent experiments on these hardy young Amphibians showed that the decapitated larvae grow slowly, but with apparent normality; move less than usual, but normally enough; are pigmented much as usual; heal their wounds as usual, but at a slower rate; and regrow their lost gills. A remarkable fact is that the reäctions to light are essentially the same, which shows that there must be a dermatoptic sense able to compensate for the absence of eyes. The case of this Amphibian is a fine illustration of the plasticity or elasticity of some forms of life.

REVIEWS.

ASTRONOMY.

The Call of the Stars.—By J. R. KIPPAX, M.D. 432 pages. 54 illustrations. 9-in. × 6-in.

(G. P. Putnam's Sons. Price 10/6.)

Yet another book for the amateur astronomer and general reader who has predilections for this subject. It is a substantial volume, and we find that it contains practically everything that such readers can require, without diving into the domains of the more technical and professional astronomer. The author does not claim the introduction of any novelties—it is hard to see how any author could do so, as so many astronomical books have been published in recent years. But, although he has largely drawn upon other authors' works, as is unavoidable—for this he gives very generous acknowledgment—there are repeated cases of the author's own expressions.

"The design of this volume is to present, in plain, non-technical language a concise and accurate story of the starry heavens, together with the legendary lore that time and fancy have associated with them. . . . The book is not intended for the professional reader, who is doubtless already familiar with the facts here given, but for the lay reader, who has but limited time to devote to the subject." We think the author has succeeded in attaining his object, and we believe that the book has only to be seen and it will recommend itself. The book should certainly be included in the library of all keen readers of "Astronomy," of which one page is worth a whole "novel."

The arrangement of the book consists of two parts, one the Stars and the other the Sun and the Planets. The first part is divided into eight chapters. After the first, on General Remarks, follow five chapters on the Night Sky of Spring, Summer, Autumn, and Winter; then one on the Milky Way, Nebulae, Variable Stars, etc.; and the last on Stellar Distances, Spectrum Analysis, and Celestial Photography. Part II contains two chapters on the various theories or systems, then eight chapters relating to the Sun, the Moon, and major Planets, and the last treats of Comets and Meteors. Following this is a good index, though we notice some omissions, which gives the useful pronunciation of the constellations and Arabic names.

In the pages 32 to 216, which are mainly descriptive of the constellations, their configurations, and individual stars, the author gives numerous and appropriate poetic allusions—as in other parts of the book. The information throughout is quite up to date, and the selection of the illustrations—mainly whole plates—has been drawn from the best sources. We notice the omission of some important books in the list of authorities consulted; other omissions and inaccuracies in the whole book are very slight and small in number.

The paper and printing are excellent, as might be expected from the "Knickerbocker Press"; the price is quite moderate.

F. A. B.

CHEMISTRY.

Physical Chemistry. Its Bearing on Biology and Medicine.—By J. C. PHILIP, M.A., D.Sc. Second Edition. 326 pages. 24 illustrations. 7¼-in. × 7¼-in.

(Edward Arnold. Price 7/6 net.)

The methods of physical chemistry are being applied to an increasing extent to the solution of problems of biology and physiology, and the aim of this book has been to give an outline of this branch of the science, with especial reference to this particular purpose. The appearance of a new edition within a year or two of the first publication is a matter for congratulation to the author, and a proof that the book has satisfied a demand. The present edition follows the lines of its predecessor, and discusses with sufficient detail for theoretical purposes such subjects as Osmotic Pressure, Colloidal Solution, Adsorption, and the Velocity of Chemical Reäctions, including the physics of enzymic action. The new matter includes a brief outline of Czapek's researches upon the Permeability of the Cells of Higher Plants and a chapter on Electro-motive Force,

XUM

References are given to the original publications quoted, and there is an excellent subject index and index of authors. The book is a welcome addition to the library of all whose work is concerned with the chemistry of the life processes of animals or plants.

C. A. M.

ENGINEERING.

The Calculus for Engineering Students.—By JOHN GRAHAM, B.A., B.E. 355 pages. 7½-in. × 5-in.

(E. & F. N. Spon. Price 5/- net.)

The demand for this concise little textbook has necessitated a fourth edition, which indicates that it supplies a much-felt want. The general arrangement is good, and enables the student to progress on sound lines.

In the introductory chapters the author summarises certain algebraic and trigonometrical theorems, a clear knowledge of which is essential if any advance is to be made in the study of the Calculus.

A good feature in the body of the book is the insertion of the solution immediately after each problem, which effects a saving of time to the reader, and enables many problems to be utilised as a reference list for Differential or Integral results.

The first eleven chapters are devoted to progressive instruction in the Differential Calculus, followed by eleven on the Integral Calculus and its applications, the concluding eight chapters being chiefly devoted to the solution of Differential Equations. The author is to be congratulated on the use made of graphical demonstrations of the elementary theorems of the Calculus, which should enable the beginner to readily grasp the principles involved. For the sake of clearness, however, fundamental theorems might be printed in heavier type.

The textbook includes the mathematical investigation of many standard formulae connected with Mechanics, Electrical and Mechanical Engineering. A slight lack of precision in definition is noticeable here and there; as, for example, in the opening definition of a periodic function on page 184. The value of the set of miscellaneous examples at the end would be enhanced if the solutions were indicated. After all, a textbook is better not to be a hunting-ground for home work or examination problems. A few minor errata and omissions were noted on a first reading, but these will no doubt be remedied in the next edition.

Apart from the minor points touched on, the author is to be congratulated on a most useful addition to the library of the engineering student who desires a working knowledge of Elementary Calculus.

J. K. R.

GEOLOGY.

The Quaternary Ice Age.—By W. B. WRIGHT. 464 pages. 155 figures. 23 plates. 9¼-in. × 5¾-in.

(Macmillan & Co. Price 17/- net.)

There is no general work in English, says Mr. Wright, which might serve as a guide to the literature of glacial geology, or enable the geologist to grasp the leading features of the subject. The present volume not only fills this want, but contains a great deal of reasoning and speculation, for which the author himself is responsible. The glaciation of Europe generally, of the Alps, and of North America, is discussed in detail. In the present state of our knowledge a correlation of the various stages in the different countries can only be surmised. Mr. Wright looks to archaeology in the near future to make clear the relation between the North European and Alpine glaciation, but he is not so hopeful in the case of Europe and North America. As illustrating the slowness with which a fundamental idea creeps into geological science, we may mention the theory of the production of the deposit known as loess by the wind.

Not the least interesting chapters are those which deal with quaternary mammals and with man. The latter includes a most useful summary of the various stages in palaeolithic culture, and a discussion of the transition period which leads to the neolithic, as well as a consideration of the latter itself. The theories of the Ice age are outlined, and, as the researches which have been made in Scandinavia into post-glacial geology are world-famous, the oscillations of level in that part of Europe are described with considerable care. Mr. Wright develops to a considerable extent the isostatic theory put forward by Jamieson, to whom the volume under consideration is dedicated. The theory implies that there is a certain amount of hydrostatic balance between the different elements of the Earth's crust, so that if an additional load be imposed on any portion of the surface, it must necessarily sink, and the remainder of the surface rise until equilibrium is reëstablished. Examples of such loads are to be found in the accumulations of sediment round the mouths of great rivers. The isostatic depression of ice-sheets is that, however, which occupies Mr. Wright's attention, and he claims that it has attached to it a very high degree of probability. In fact, one of the important points in his book is his endeavour to show that the complicated Earth movements which have in the past been commonly evoked to explain the late glacial and post-glacial changes of level in Scandinavia are not at all necessary, and that all the observed phenomena may be accounted for in the simplest manner by unchecked isostatic recovery from the effects of the ice-load, combined with a single oscillation of the sea level.

A pertinent quotation from Gilbert says: "When the work of the geologist is finished, and his final comprehensive report written, the longest and most important chapter will be upon the latest and shortest of the geological period." Those who read carefully what Mr. Wright has to say will agree most thoroughly with his concluding words, that we have in the history of the quaternary period a region of research full of hope and of the most romantic interest, promising not only to reveal the events which have accompanied and influenced the evolution of man, but to afford an outpost from which we can look back into the ages which preceded his advent upon the Earth.

We are kindly permitted to reproduce one of the plates in Figure 276 (see page 272), and we may further say that the illustrations are most helpful, and add to the value of the book, which should be on the shelves of every naturalist and archaeologist.

W. M. W.

METEOROLOGY.

Climate and Weather of Australia.—By H. A. HUNT, GRIFFITH TAYLOR, and E. T. QUAYLE. 93 pages. 39 plates. 9¼-in. × 6-in.

(Melbourne: A. J. Mullett. Price 5/-.)

This is one of the publications issued by the Commonwealth Bureau of Meteorology, and is a concise and valuable textbook on Australian Meteorology.

In area Australia is about three-quarters that of Europe, and contains (with Tasmania) 2,974,581 square miles. It is characterised by a very uniform outline, and by a lower average elevation than any other continent. Since Australia extends over so many degrees of latitude, its northern area comes under the inflence of equatorial conditions, where the four seasons are not so well marked as, for instance, in Europe. Here the major divisions are the wet and dry seasons. But there is a difference of ten degrees between the mean temperatures of January and July, and there is a remarkable dissimilarity between the muggy conditions in January—when the heaviest rain for the year falls—and the dry heat of July. In the southern area the division of the year into four seasons is well marked, though over the greater portion of the year definite wet and dry periods are still noticeable.

The highest temperatures are recorded over the north-western portion of Western Australia, where the maximum shade temperatures have exceeded one hundred degrees on sixty-four consecutive days and ninety degrees on one hundred and fifty consecutive days, the mean temperature

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of the hottest month being ninety degrees and that of the coldest month sixty-five degrees.

The coldest portion of Australia is the Australian Alps, situated in North-eastern Victoria and South-eastern New South Wales, where the mean shade temperatures range from sixty-five degrees in January to forty degrees in July. During exceptionally dry summers the temperatures in the interiors reach, and occasionally exceed, one hundred and twenty degrees, and the same areas during the winter months are subject to ground frosts.

Australian weather is controlled by three belts of atmospheric eddies. In the north, moving generally from west to east, along the Tropic of Capricorn, is a procession of low-pressure systems which are usually termed "monsoonal lows." South of latitude forty degrees is another series of cyclonic eddies—probably secondaries strung along the great low-pressure belt of the Southern Ocean. These are called "antarctic cyclones." Between the two lies the belt of anticyclones whose path swings between latitude thirty degrees and forty-two degrees as the Sun moves south and back again.

The whole coast of Australia, from Perth northward and east to Brisbane, is at times influenced by the South-east Trade Winds. The rains of Australia fall mainly in connection with the tropical depressions and the southern or antarctic depressions. The former rain-bearing factor operates over two-thirds of the continent, roughly, over that portion of Australia lying to the north of a line extending approximately from Cossack, on the north-west coast, to Sydney, on the south-east coast, the rainy season being from December to March inclusive, and the wettest month January. The remaining third of Australia's area receives its rains principally through the southern depressions which operate during the autumn, winter, and spring months, with the heaviest monthly totals in June.

Space will not permit any further details to be given, but the authors deal with many other climatic features, and also with the characteristics of drought years and of local rains, as well as special types of weather. The book is copiously illustrated with maps and charts, showing mean monthly and annual temperature, pressure, and rainfall, as well as types of weather and special phenomena.

W. M.

NATURAL HISTORY.

Odd Hours with Nature.—By ALEXANDER URQUHART. 323 pages. 32 illustrations. 8¼-in. × 5¼-in.

(T. Fisher Unwin. Price 5/-.)

There are many articles written nowadays for the general press which contain interesting observations on natural history, and it would be a pity if, after they have served their immediate purpose, all of them were lost. Hence we welcome the series of essays, written for *The Dundee Advertiser*, which Mr. Urquhart has collected under the title of "Odd Hours with Nature." We may take at random one or two of the subjects discussed. In one article the house-sparrow and the tree-sparrow are compared as regards their appearance and their psychology. The robber bees who pierce the spurs of the Delphiniums form the subject of another essay; that wild cats are not so scarce as might be imagined is brought out in the third; while such subjects as wasp-plagues, the winter play of birds, and the assuming of male plumage by hen birds, go to make up an interesting whole. Figure 275 (see page 272), from a photograph by Mr. Charles Reid, of two wild cats, is reproduced by permission from "Odd Hours with Nature."

W. M. W.

PHYSICS.

A Text-book of Physics.—By J. H. POYNTING and SIR J. J. THOMSON. Volume IV. Electricity and Magnetism. In Three Parts. Parts I and II. Static Electricity and Magnetism. 345 pages. 246 illustrations. 9-in. × 6¼-in.

(C. Griffin & Co. Price 10/6.)

The appearance of this new instalment of an important text-book was separated by only a few days from the announcement of Professor Poynting's death, and so a melancholy interest attaches to the volume under consideration. The admirable characteristics of the earlier volumes, on Properties of Matter, Sound, and Heat, are again evident in the new one. The chapters on Static Electricity begin with a clear and well-selected account of common phenomena. This serves as an introduction to the measurement of electrical charge, strain, and potential, the presentation of the notions being marked by an intimate acquaintance with the difficulties of the average student. Needless to say the development of Faraday's treatment of the subject, which we owe to Sir J. J. Thomson, is not missing. In the Magnetism chapters, again, the same method of treatment is followed, a simple account of the elementary facts coming first. The subsequent development of theory is accompanied throughout by a full statement of experimental results, and the chapters on Permeability, and on Magnetism and Light, are remarkable for completeness and clearness of exposition. The Electron theory is only occasionally introduced, its full consideration being deferred to the companion volume, on Current Electricity, which Professor Poynting's preface leads us to expect shortly.

W. D. E.

X-Rays: An Introduction to the Study of Röntgen Rays.—By G. W. C. KAYE, Head of the Radium Department at the National Physical Laboratory. 252 pages. 97 illustrations. 8¾-in. × 5½-in.

(Longmans, Green & Co. Price 5/- net.)

This fascinating book on x-rays will receive a warm welcome from all those who have been attracted by the developments of modern physics. The literature of the subject is now so extensive that it is impossible for any but a specialist to collate the material adequately, and the work before us by one who has contributed in no small measure to the subject is unapproached in authority among existing English books. To medical men especially the book will be invaluable.

There are thirteen chapters in the volume, together with an Introduction and five Appendixes, the unusually large number of the latter being attributable doubtless to the rapid growth of the subject while the book was in the press. (We noticed one reference as late as April, 1914.) The early chapters give a clear account of the chief features of a vacuum-tube discharge, and one can readily appreciate the important parts played by both the cathode rays and the positive rays in an x-ray bulb.

Following this is a simple account, for the benefit of the novice, of the method of generating x-rays. The historical and present-day development of the x-ray bulb is fully gone into. There is a good chapter on induction coils, Wimshurst machines, and so on, followed by one dealing comprehensively with the various methods of testing and measuring x-rays both in quality and quantity. One of the best sections in the book is that on monochromatic x-rays, the characteristic x-rays of Barkla. Then comes an account of C. T. R. Wilson's condensation experiments illustrated by several plates.

The present state of x-ray radiography and radiotherapy is well set out in later pages, which display some good examples of modern x-ray technique.

One of the most satisfying chapters is that which expounds the very recent and important work of Bragg, Moseley, Lane, and others on the diffraction of x-rays by the serried rows of atoms in a crystal. This work, which has settled conclusively that x-rays are an extreme form of ultra-violet light, bids fair to establish a new branch of crystallographic physics of surpassing importance. The final chapter deals with the nature of the x-rays; and the Coolidge x-ray bulb is described in an Appendix.

Sir James Mackenzie Davidson contributes a delightful

story of the discovery of the *x*-rays by Professor Röntgen in 1895, and the book is further enlivened by the presence of a clever parody on the circumstances attending the genesis of an *x*-ray.

Many workers will find the numerous tables which are scattered throughout the book of great value.

To summarise, Dr. Kaye has accumulated a great deal of valuable information in his book, and has put it out in a very compact and interesting form. The appearance of the book is unusually attractive, and the diagrams and plates, of which there are close on a hundred, deserve a word of praise.

We consider that for some time to come this will be the classic book on *x*-rays, to which the student may refer with the full conviction that he will find an absolutely scientific and reliable guide.

W. D. B.

ZOÖLOGY.

A Text-book of General Embryology.—By WILLIAM E. KELLICOTT. 376 pages. 167 illustrations.

Outlines of Chordate Development.—By WILLIAM E. KELLICOTT. 471 pages. 185 illustrations.

Both volumes 8-¾in. × 5½-in.

(Constable & Co. Price 10/6 net each volume.)

Embryology and development, which are, in reality, no more than different grades and aspects of one and the same subject, ought to form the most fascinating of all branches of zoölogical studies, showing, as they do, how there is a gradual transition and advance from the simple dual fission of the lowly monad to the complicated and elaborate series of changes undergone by the human embryo before culminating in the birth of a being but one degree lower than the angels. And yet how comparatively small is the number of zoölogists who know anything at all, or, at any rate, anything worth knowing, of this marvellous and fascinating science, most of them being content to go on from year's end to year's end describing so-called new races or species in the belief that such work constitutes the final end and aim of zoölogy. To such we say, although we fear that we say it in vain: Learn to know something of yourself, and of the ties by which you are bound on the one hand to the lowest members of the animal kingdom, while on the other, if we may say it with all respect and deference, you lay claim to kinship with the eternal and omnipotent Godhead.

To those who feel the sting of this reproach, and respond to the stimulus for a desire for better things, and a wider field of thought, we can confidently recommend the two excellent little volumes which form the subject of this notice. For, although designed by an expert teacher for the use of his students, they are so thoroughly well written and so excellently well illustrated that they can be read by anyone with a fair knowledge of anatomy and zoölogy, not only without difficulty, but with actual pleasure and appreciation. It may be added that since the first part of Dr. Prziham's well-known text-book of Embryogeny was published so long ago as 1908, Professor Kellicott, who, by the way, occupies the Chair of Biology at Goucher College, has much to tell us that is not to be found in works hitherto available to the student.

In the first of the two volumes—"A Text-book of General Embryology"—the author, after repeating the old saw, in English, of "*omne vivum ab ovo*," commences with a chapter on Ontogeny, in which are reviewed the processes of reproduction by fission, budding, and ovulation, culminating in the last case by the development of a placental connection between the maternal parent and the embryo formed from the small-yolked ovum, so different in character and function from the big-yolked egg of the Sauropsida and Monotremata. Of surpassing interest are the paragraph and diagram in this chapter descriptive and illustrative of the marvellous and fascinating theory of the continuity of the germ-plasm. The cell and cell-division, germ-cells, and their formation, maturation, fertilisation, and cleavage (of the ovum), form the titles of succeeding chapters, which are followed by others dealing with differentiation, heredity, and sex-determination in the germ-cells, and the nature and development of the blastula, gastrula, and germ-layers.

The second of the two volumes—"Outlines of Chordate Development"—may be regarded as a sequel to the first, dealing as it does with the derivation of the vertebrate phylum from some type of invertebrate stock by means of an organism more or less nearly (or shall we say remotely ?) related to the lancelet, and culminating in the developmental history of man himself, from the early embryonic stage to the full-time foetus. If such a comparison be not invidious, it may be said, indeed, that this volume is of even greater interest than its fellow. As usual in works of this nature, a large amount of space is devoted to the development of the lancelet (*Amphioxus*) and the frog, the latter showing the leading features of vertebrate development much better than any other animal. In regard to the lancelet the author observes that, whether or no it represents a really primitive type of development, it affords, in simple style, the essentials of early chordate autogeny, such specialised features as occur in the later stages merely serving to warn the careful student against drawing too precise phylogenetic inferences from embryological facts. The chapters on the Chick are shorter, and, to a certain extent, supplemental to those on the Frog. The final chapter, on Mammalian Development, includes only those phases that are of chief interest to the general student, namely, the earlier stages in the development of the embryo, the establishment of its connection with the maternal organism, the development of the foetal membranes and appendages, and, lastly, that of the external form in the later phases of the human foetus.

While according the highest praise of which we are capable to these two excellent and readable volumes, we must enter a word of protest against the eccentricities in spelling with which they are in places disfigured. The worst of these occurs on page 350 of the "Chordate," where we find "roughing-in" apparently doing duty for "roofing-in," which is neither more nor less than an insult to an English reader.

R. L.

Artificial Parthenogenesis and Fertilisation.—By JACQUES LOEB. 312 pages. 77 illustrations. 8¾-in. × 5¾-in.

(University of Chicago Press. Price 10/- net.)

The present volume is not only a condensed account of Professor Loeb's previous researches, but it contains the author's recent additions, and is quite up to date. Like all Professor Loeb's writings, it is direct and to the point, containing not a superfluous word, with no attempt at fine writing, or indeed a literary polish. But the marvels it deals with require, like good wine, "no bush." When one compares the state of our knowledge as to the processes of fertilisation, and maturation of the ovum when the Brothers Hertwig first published their experimental observations in 1887 with what it is nowadays, largely due to the work of Professor Loeb and his school, it is difficult to believe that but twenty-seven years have elapsed. The book should be in every zoölogist's library, and it will appeal equally to the botanist, the physiologist, and the physiological chemist. Every page is well worth reading, but the busy teacher who is not a cytologist will probably gain most by perusal of the first, second, ninth, twenty-second, and last chapters. The work described is chiefly experimental, and those who wish to learn the views of a master craftsman like Professor Loeb towards such questions as Vitalism and the Mechanism of Living Matter must seek them elsewhere. In the present volume the author has "let a plain statement suffice," but one that is of surpassing interest and importance.

M. D. H.

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NOTICES.

THE INSTITUTE OF METALS.—The autumn conference of the Institute of Metals is to be held at Portsmouth on September 10th and 11th, 1914.

THE LIVINGSTONE COLLEGE YEAR BOOK, 1914, contains an account of recent progress in tropical medicine, and reviews of medical and hygienic literature of interest to Livingstone College students, many of whom become missionaries in tropical countries.

NATURAL PHILOSOPHY.—Professor T. R. Lyle, M.A., D.Sc., F.R.S., is resigning the Chair of Natural Philosophy in the University of Melbourne. The emoluments attached to this post amount to about £1000 per annum. Professor Lyle's successor (who has not yet been appointed) will enter upon his duties at the beginning of the next academic year, the end of February, 1915.

THE GOLD MEDAL OF THE AËRONAUTICAL SOCIETY.—The Council of the Aëronautical Society of Great Britain has awarded the Gold Medal of the Society to Professor G. H. Bryan, Sc.D., F.R.S., for the great services he has rendered to Aëronautics by his development of the theory of the Stability of Aëroplanes. Previous recipients are Wilbur and Orville Wright (1909) and Octave Chanute (1910).

DURBAN MUSEUM.—We welcome the appearance of the first number of the Annals of the Durban Museum, which will be issued at intervals when matter for publication is available. The part before us contains papers on the pelagic Entomostraca of Durban Bay and on the South African Porpoise, while the Editor, Mr. E. C. Chubb (Curator of Durban Museum), contributes a descriptive list of the Millar Collection of South African Birds' Eggs.

THE PHOTOGRAPHIC SURVEY AND RECORD OF SURREY.—In the year 1913 nine hundred and twelve prints were added to the collection, which now numbers six thousand eight hundred and five, and one hundred and six lantern slides were received, bringing up the total to one thousand four hundred and thirty-four. The public made eight thousand one hundred and ninety-three references to the Survey Collection during the year 1913.

THE MUSEUMS CONFERENCE AT HULL.—Number 101 of the Hull Museum Publications contains reprints of the Museums Committee minutes, and of the account of the Museums Association Conference at Hull in 1913, together with a paper by the Curator, Mr. T. Sheppard, which describes how the various museums of Hull were secured, and incidentally how the writer makes the most of his opportunities. Curators of local museums should find the paper very stimulating.

SELBORNE LECTURES. — The Extension Lecture scheme of the Selborne Society has become so successful that it has been found possible this year to issue a handbook of fifty pages, giving particulars of the lectures. There are many local societies which cannot afford big fees, and plenty of county people who are glad to arrange lectures in their villages: to these the handbook should prove most useful. Particulars can be obtained from the Extension Lecture Secretary, Mr. Percival J. Ashton, at 37, Walbrook, E.C.

THE EGYPTIAN ZOÖLOGICAL GARDENS.—We have been favoured with a copy of Captain Stanley Flower's Report of the Zoölogical Gardens at Giza, near Cairo, for the year 1912, issued by the Egyptian Ministry of Public Works, from which it appears that this admirably managed institution continues to make the progress for which it has been noted during the last few years. Among numerous illustrations, especial interest attaches to one of a young Blue Nile Elephant, as showing the enormous ears characteristic of that race.

MESSRS. SIMPKIN, MARSHALL & CO. have issued a third edition of the A B C Guide to Astronomy by Mrs. H. Periam Hawkins (price 1/6 net). In this edition Mrs. Hawkins has had the assistance, not only of Dr. Crommelin, but also that of Messrs. W. F. Denning, J. A. Hardcastle, and H. P. Hollis. The Guide forms a most estimable book for quick reference for all amateur astronomers. The Revolving Star Map (1/-) has been greatly improved this year by the addition of a movable declination scale, while the Star Almanack retains its high standard of excellence.

THE BRITISH ASSOCIATION.—Those members of the British Association who do not journey to Australia this summer will be welcomed by the French Association for the Advancement of Science at its Havre meeting from July 27th to August 2nd. All that is necessary is for the visitor to possess a British Association ticket. New members may be enrolled on the introduction of an old member, and relatives of members accompanying them or persons recommended by members of the Association will be enrolled as Associates for the purpose of attending the meeting at Havre. The Associate's subscription is one pound. Copies of the provisional programme, and any further details, can be obtained from the Assistant Secretary of the British Association, Burlington House, London, W., and application must be made not later than July 18th. Dr. A. Loir, Comité Local de l'Association Française, Bureau d'Hygiène, Hôtel de Ville, Le Hâvre, has kindly undertaken to deal with any communications addressed to him from members with regard to hotel accommodation, which may be obtained at from twelve to twenty francs per diem. The Conference of Delegates of Corresponding Societies of the British Association will meet officially at Havre on Tuesday, July 28th. The Chairman is Sir H. G. Fordham, the Vice-Chairman, Sir E. Brabrook, and the Secretary, Mr. Wilfred Mark Webb.

THE COMMITTEE FOR THE ECONOMIC PRESERVATION OF BIRDS.—As the views of the Committee for the Economic Preservation of Birds have been either misunderstood or misrepresented, the majority of the members has signed a letter in which the following six suggestions are put forward as a working basis: (1) Absolute protection during breeding season for all breeding wild birds of whatever kind. (2) Absolute protection for all birds found upon enquiry to be either verging upon extinction, highly localised, or of determined benefit in agricultural centres. These birds to be known as " Birds of Class I." (3) Regulations to be enforced by Government or local authorities under Government for species that have commercial value and are not in danger. These birds to be known as " Birds of Class II." The Government of the countries of origin to tax the sale of these species, and thereby recover the cost of enforcing regulations. (4) The permanent maintenance of an International Committee of Scientific experts to determine year by year which species belong of right to the respective classes. (5) An International Agreement to refuse importation to the world's markets, museums, and private collections of all species that are found to belong to " Class I." (6) All species in " Class II " to be exported under licence. A list of the birds is also given which would at once come into Class I, and the following are the signatories: Dr. P. Chalmers Mitchell, F.R.S. (Chairman); F. G. Aflalo; Dr. Dudley W. Buxton; C. F. Downham; F. Martin Duncan; G. K. Dunstall; Douglas English; Professor J. Stanley Gardiner, F.R.S.; Professor Marcus Hartog; W. D. Henderson; M. Davenport Hill; H. Knight Horsfield; Louis Joseph; Professor H. Maxwell Lefroy; Sir Edmund Giles Loder; Professor E. W. Macbride, F.R.S.; Professor A. Meek; Professor E. A. Minchin, F.R.S.; C. E. Musgrave; Professor Robert Newstead, F.R.S.; Hubert H. Poole; Robert H. Read; Hugh Scott; Professor C. G. Seligmann; A. E. Shipley, F.R.S.; The Rev. Thomas R. R. Stebbing, F.R.S.; Professor D'Arcy W. Thompson, C.B.; Professor J. Arthur Thomson; Hugh Boyd Watt; W. Percival Westell; A. Wingfield; S. L. Bensusan and Wilfred Mark Webb, Secretaries.